Landscape for a low-carbon future: guidelines for CO_2 reduction through land uses changes in Catalonia

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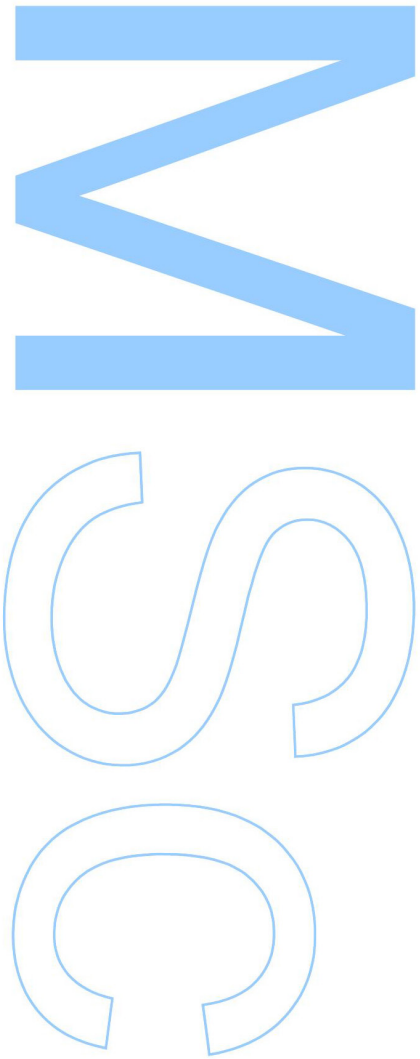

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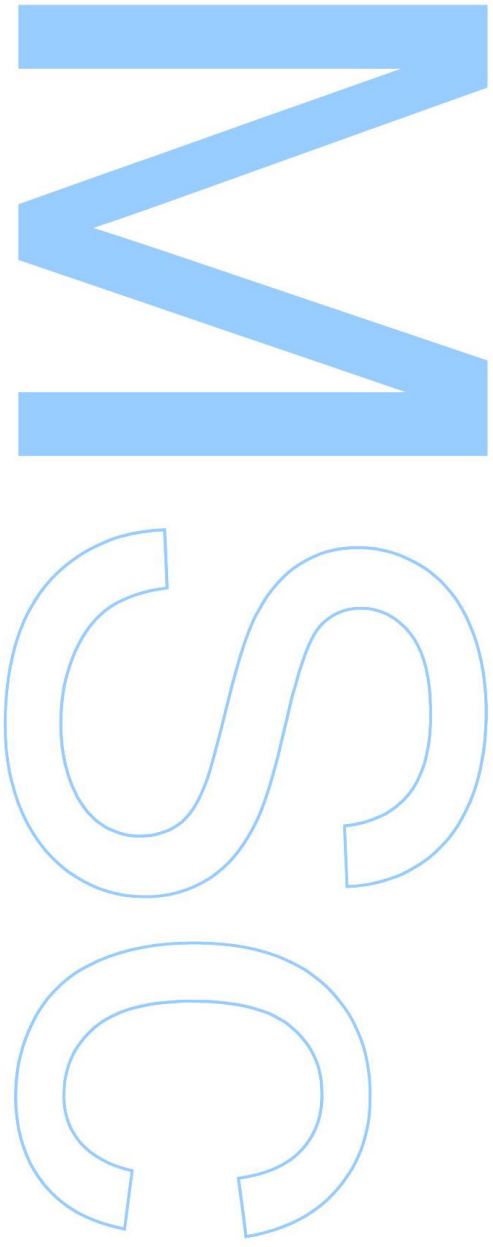

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To my classmates !

Abstract and Keywords

Low carbon society is a term used in several studies and revers to a society that emit low quantities of CO_2. In this study will be evaluated the land uses of a Landscape Unit and calculated the quantity of emissions and with changes in the land uses associeted to the Landscape Quality Objectives, improving them to reduce the emissions.

The Case-studies chosen were two Landscape Units, Plana de la Selva and Terraprims, present in one of the seven Landscape Catalogues from the Landscape Observatory of Catalonia.

The study aims to propose a list of guidelines that can be applied to the different land uses and contribute to the reduction of CO_2 emissions without transforming the character of the landscape.

Keywords: Low Carbon Societies, Catalonia, Landscape Units, Land uses, Carbon emissions, Carbon capture.

Resumo e Palavras Chave

Sociedades de baixo carbono é um conceito usado em diversos estudos como uma sociedade que emite a menor quantidade de carbono possível. Neste estudo serão quantificada as emissões de carbono por ocupações do solo de um território, tentando alterá-las e melhorá-las com o intuito de diminuir as emissões de carbono em toda a Paisagem.

Os caso de estudo escolhidos são duas Unidades de Paisagem, Plana de la Selva e Terraprims, descritas nos Catálogos de Paisagem do Observatório da Paisagem da Catalunha, instituição criada pelo Governo da Catalunha com o intuito de implementar as leis da paisagem.

O estudo tem como objetivo propor uma lista com linhas orientadoras que puderam ser aplicadas a ocupações do solo e contribui para a redução de carbono sem a alteração do carácter da paisagem.

Palavras-chave: Sociedades de baixo carbono, Catalunha, Unidades de Paisagem, Unidades de Paisagem, Emissões de Carbono, Fixação de Carbono.

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Abbreviations

LCS - Low Carbon Society

CO_2 - Carbon Dioxide

LQO - Landscape Quality Objectives

GHG - Greenhouses gas

LOC - Landscape Observatory of Catalonia

LU - Land uses

LC - Landscape Catalogues

CREAF - Centre for Ecological Research and Forestry Applications

IDESCAT - Institut d'Estadística de Catalunya - Statistical Institute of Catalonia

Introduction

I - Theme

The internship took place in the Landscape Observatory of Catalonia situated in the city of Olot, with duration of 6 months and oriented by the coordinator and director of the Landscape Observatory, Pere Sala i Martí and by the guest lecture from the Faculty of Science of Porto University, Carla Gonçalves. The internship and this report represent the final step to graduate in the Master in Landscape Architecture from Faculty of Science of Porto University.

The subject of this report and the theme of the internship witch aboard the study of climate changes and their influence in the landscape, having as a basis the landscape study already made by the Observatory about Catalonia's landscape, its evaluation, evolution and quality objectives.

Since the Convention on Climate Change many studies started appearing explaining climate change and its impact on society, justifying the reason for the climate changing so fast in such a short amount of time, clarifying the effect of CO_2 in the atmosphere and in the ozone layer, illustrating new ways of getting energy without the use of unrenewable energies. All these studies result in a change of a mindset, creating the need of new energies sources, recycling and the change of others Human behaviors that have contributed for the increase of CO_2 in the atmosphere.

The Paris Agreement (2015) emerged, after the Kyoto protocol (1997) when this don't achieved their marks, to mitigate the effect of the global warming caused by the accumulation of CO_2 in the atmosphere, that was sign by 197 countries.

The theme of this study is the relation between the Landscape Units and the emissions of carbon dioxide and how to reduce these emissions through alterations on the landscape having into account the Landscape Quality Objectives proposed by the Landscape Observatory of Catalonia, ensuring the perpetuation of the Landscape Character as well as the reduction of CO_2 emissions.

II - Questions to be answered

This study intends to apply the concept of low carbon society into a landscape reducing the

emissions while preserving the landscape character through the Landscape Quality Objectives delineate to the Landscape Unit. To achieve this aim is necessary to answer some questions as:

- Which changes in the landscape should happen to achieve a low carbon unit?
- Which are the main sources of carbon in the landscape unit?
- What is the capacity of the land use, existing in the unit, to capture carbon?
- Are the Landscape Quality Objectives in concordance with a Low Carbon Society?

III - Aim

The theme of the final report makes a connection between climatic changes and landscape to be able to make this connection several aims had to be achieved, such as:

• Characterize the concept of a Low Carbon Society;

• Analyse successful study cases of Low Carbon Societies;

• Comprehend the methodology of the Landscape Catalogues and Landscape Units of Catalonia;

• Propose a Guideline and measures that facilitates the achievement of a Low Carbon Society;

• Analyse of the landscape units of Terraprims and Plana de la Selva and their land uses to implementation of the guidelines;

• Convert Plana de la Selva and Terraprims into a Low Carbon unit.

IV - Methodology

This report can be divided in two logic parts, the first is the theoretical information about climate change, climate change conventions, new laws implementations, Low Carbon Societies and Guideslines proposed of how to become a Low Carbon Society. The theoretical part has the information about the European Landscape Convention that originated news laws in Catalonia, leading to the creation of the Landscape Observatory of Catalonia, where the Landscape Catalogues and the Landscape Units were established and publish. This theoretical part works as gathering of information to be applied in the second part.

The second part is the application of theoretical information to two Landscape Units, using the data study and guidelines proposed, with specific solutions to transform the landscape unit into a low carbon one, based in the Landscape Quality Objectives.

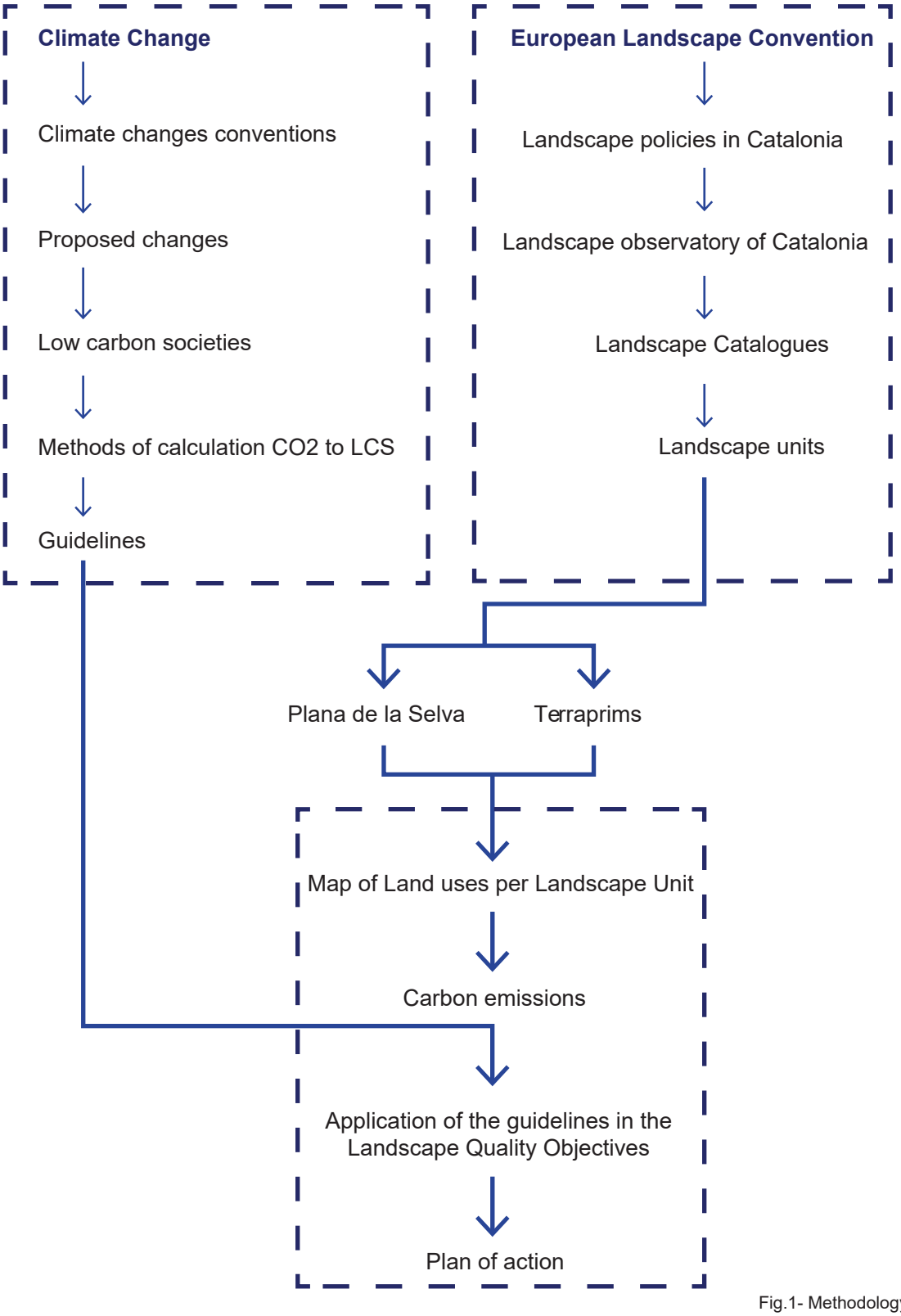


Fig.1- Methodology

V - Structure of the report

This report begins with the present chapter, Introduction, where is presented the theme, questions to be answered, aims and methodology.

The chapter 1 aboard the concept of Low Carbon Society, explaining their origin goals and methods to achieve one.

Chapter 2 is where the land uses and the concept of Low Carbon Society meet in proposed measures based in diverse bibliography compile in this study, called Guidelines.

The Chapter 3, is a summary of the changes in the legislation of Spain and more specifically in Catalonia that allow the formation of the Landscape Observatory of Catalonia and subsequent studies and mapping of the landscape of Catalonia.

Chapter 4 talks about the two landscape units (case-studies) of Catalonia where will be apply the proposals in this study, is the chapter where is showed the evolution of the land uses, between 2005 and 2009 in these two landscapes as well as the landscape quality objectives to this two units showing the importance of the study of the landscape to apply now strategies.

Chapter 5, the proposal, where all the information obtain during the internship culminates and where proposals to change the landscapes and made a landscape low in carbon, trying to change the current trends.

The last Chapter – Conclusion and Recommendations – is presented the conclusion of this study as well as the recommendations to achieve better results and proposal of futures works.

Chapter 1 - Low Carbon Society

"Low-Carbon Society is defined as one which aims to minimize carbon emissions in all sectors, shifting to a simpler and high-quality life, coexisting with nature" (Universiti Teknologi Malaysia et al. 2012)

1.1 - Convention and Agreements

The United Nations Framework Convention on Climate Change (1992) identifies the agenda for intergovernmental efforts to oppose the climate change. The climate system is a universal resource whose stability must be maintained by all. The industrial CO_2 emissions and other CO_2 sources affect the climate considerably, for that reason, by 2014, one hundred and ninety-seven parties[1] had ratified the convention, ensuring a better control over the greenhouse gases emissions by the different countries. They share information on greenhouses gas emissions every year since 1990 (base year), and launch national strategies for the greenhouse gases emissions that are adapted according to its impacts.

United Nations Framework Convention on Climate Change has defined Carbon sources as the processes, mechanisms and activities of releasing CO_2 into the atmosphere. After this definition studies start appearing and the option to reduce CO_2 in the atmosphere start to gain importance. Tree strategies to reduce carbon though landscape are presented in the Table 1.

This information are adapted from Change (2017) having into account the theme of this study.

[1]The name of the countries that ratified the convention are available in the annex X of the United Nations Framework Convention on Climate Changes.

Some of the methods of carbon source reduce though landscape design is:

• Form rational systems of landscape structure - create a continuous, uniform, heterogenic and diverse urban green space, avoiding that way the isolated green spaces. Build communication structures that allows low carbon transportation (walk or cycling), and helps reducing carbons emissions and fixation.

• Act according to circumstances, design with nature to reduce carbon emissions – be aware of the conditions of the place, using the right strategies to help the carbon fixation in the area (certain trees absorb major quantities of carbon, more efficient roads and strategic urban areas contribute for less emissions of carbon).

• Reduce carbon emission by using appropriate technology – Renewable energy sources are the best way to avoid the use of oil derivatives, decreasing the CO_2 realise to the atmosphere. Technologies like electric cars, houses isolation, bio-degradable fibers are used to achieve the same purpose.

Table 1 - Methods of Carbon sources reduce

Adapt from Change, 2017

The United Nation Framework Convention on Climate Change originated different protocols and agreements, the most importants are the Kyoto Protocol (1997) and the Paris Agreement (2016).

The Kyoto Protocol set in 1997, obligates the industrialised countries to reduce the greenhouse gases, until 2012. The emissions of greenhouse gases should have been 5% of the value register in 1990, which should have translated in less 29% of emissions in a business as usual scenario, but it wasn't so, the protocol was extended to 2020, during the conference in Doha, Qatar, with the same aims. By 2014, 192 parties had signed the protocol, which was replaced in 2015 by the Paris Agreement.

The Paris Agreement main aim is to deal with the climate change treaty by keeping the global temperature well below 2ºC above pre-industrial levels, and stop the temperature from increase even further of the 1.5ºC, value of the temperature already raised since the base year (1990). The agreement also has as goals the learning of skills by the countries to deal with the impacts of climate change, and their economy to be consistent with a low carbon emission and climate-resilient pathway (Change, 2017).

The governments that sign the agreement are obliged to report regularly on their emissions and the implement efforts. By the end of June of 2017, 153 of the 197 countries had ratified the Paris Agreement and 195 of the 197 had signed the agreement, contributing for a decrease of the global emissions.

1.2- Concepts and Goals

Low Carbon Society is a concept that has been used more frequently since the Climate Changes topic reached the United Nations Framework Convention, where the perception of a society working as a whole to lower the carbon levels, partitioning the responsibilities by politics and the average citizen. This convention appears to create awareness about the changes in the climate and the consequence of the excess of carbon in the atmosphere, trying to make all the countries to committed to reduce CO_2 emissions and preserve the environment and all the resources.

The concept of a Low Carbon Society assumed for this report is a society that reduces the quantity of CO_2 and others greenhouse gases to the minimum, by changing technology and energy sources to more environment friendly ones, by giving a “second life” to the materials from non-renewable sources, without effecting their economy growth at significant levels. (Ali et. al., 2013). This convention creates some norms that all the countries that ratify it should implement, improving the quality of the landscape was well as change it in healthier forms in a way that reduce the CO_2 emissions and preserves the world resources without jeopardizing the futures generations.

A low carbon society requires following 3 principles: reduce the CO_2 emissions to the bare minimum in all sectors, pursue a simpler but high-quality life style and respect nature. According to Skea and Nishioka (2008), a low carbon society should:

• take actions that are compatible with the principles of sustainable development;

• make an equitable contribution towards the global effort to stabilize the atmospheric concentration of CO_2 and other greenhouse gases at a level that will avoid dangerous climate change, through deep cuts in global emissions;

• demonstrate a high level of energy efficiency and use low-carbon energy sources;

• adopt patterns of consumption and behaviour that are consistent with low levels of greenhouse gas emissions.

A derivative of the concept of low carbon society is the near-zero-emissions society. The main difference is that the low carbon society tries to capture the emissions that are made as well as reduce de emissions while the near-zero-emissions try to reduce the emissions to zero. As explained above the low carbon society only can be achieved by the change in day-to-day life, in all their aspects, basically every behaviour of the society must change.

Low Carbon Society considers all the emissions of CO_2 and tries to reduce them by implementing different actions that change with the society where is being implemented.

1.3 - Methodologies and Methods

Several examples of societies that try to change for a low carbon one, can be found in studies. Most of these examples have the goals set for 2020, 2030 or 2050 so it´s not possible to have real results of the actions that were implemented in these reports. For that reason the examples present in this report are about the methods of evaluation of a society and guidelines on how to change to a low carbon society.

Achieving a low carbon society has four steps, starting with the collection of information and data sources (step 1), followed by preliminary analysis and synthesis (step 2), development of scenarios (step 3), and the final step (step 4) is the development of a low carbon society action plan. Most of the examples presented these steps with different results and place of application.

In the example of Guangzhou, Dai Qing and Matsuoka (2017) was created a methodology to achieve the low carbon society, based on “back casting” idea. Back casting is usually used as a team-oriented brainstorming tool. It was created in energy futures studies in the 1970s, and consists in a proposal, by all participants, of a future event or situation and then work backwards to construct a plausible causal chain leading from here to there (Balkissoon, 2017).

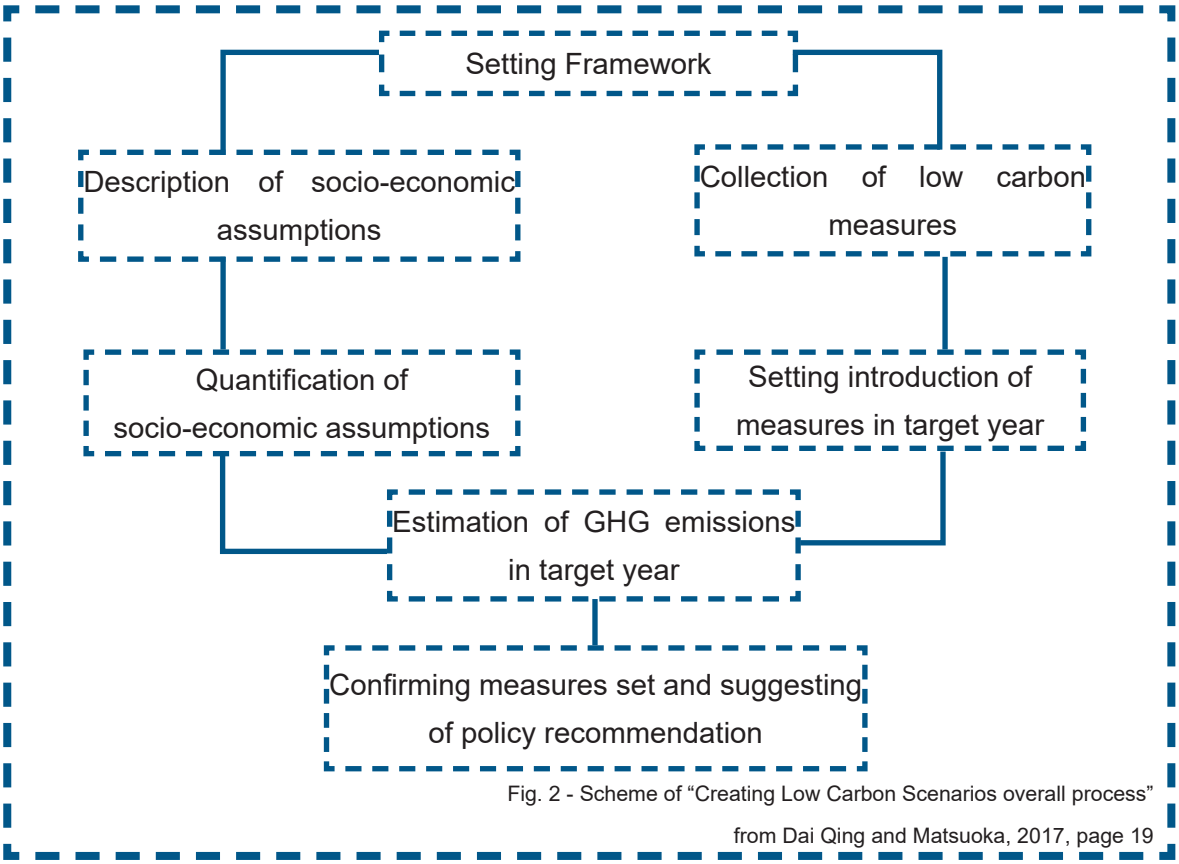


Fig. 2 - Scheme of “Creating Low Carbon Scenarios overall process” from Dai Qing and Matsuoka, 2017, page 19

This scheme (Fig. 2) represents the methodology created to evaluate a society, starting with Setting the Framework scenario that includes the target area, base year, target year, environment target and the number of the scenarios. The next step are the socio-economic situation and assumption in these two steps including the study of the lifestyle, economy, industry, land use and so on, and set the parameters for the target year such as the indices of population, industry, transport demand and so on. In the other hand, it´s necessary the collection of low carbon measures and the introduction of the counter measures available to reduce the index of the CO_2 emitted in the base year. After the last four steps completion, comes the estimation of the greenhouse gases emission in the target year, finally is elaborated a proposal of policies. (Dai Qing and Matsuoka, 2017)

Extended Snapshot Tool is a method to calculate the reduction of the CO_2 emissions of each counter measure, is a system of simultaneous equations, with seven blocks of input parameters, exogenous variables and variables between modules (see Fig. 3). This method is applied to evaluate a society after the use of the back-casting method.

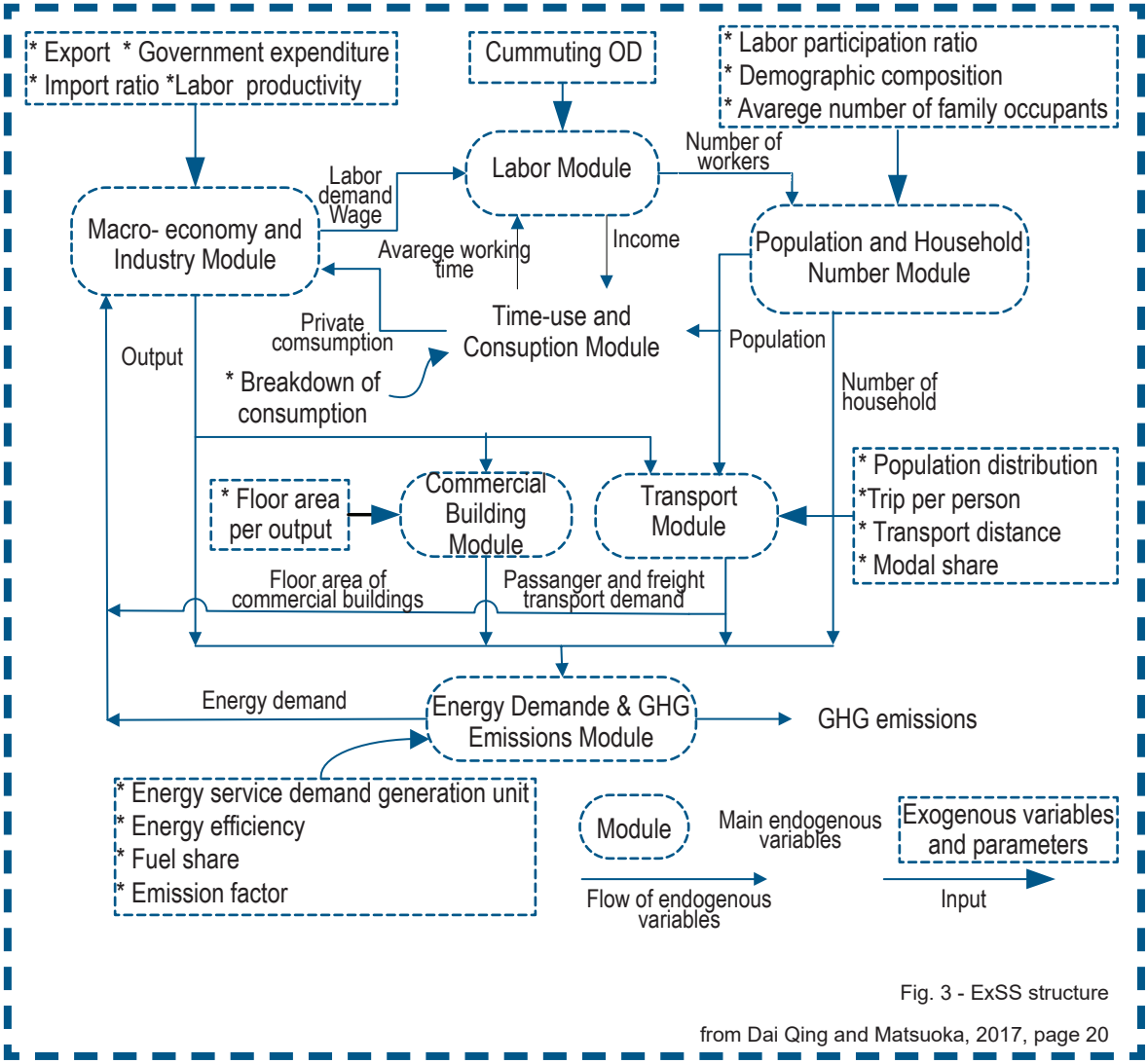


Fig. 3 - ExSS structure

from Dai Qing and Matsuoka, 2017, page 20

Other method to evaluate the CO_2 in the agriculture area/land is the Agriculture, Forestry and Others Lands Uses model (AFOLU model). This model allows evaluating the different land uses in the sector of agriculture and forestry, analysing the CO_2 emissions and capture, proposing new policies and GHG mitigation technologies. This method is applied by obtaining the information like it is presented in the following diagram (Fig. 4) by Hasegawa (2012). The information obtained with this type of model has to be analysed and applied in an action plan in the areas of forest and agriculture.

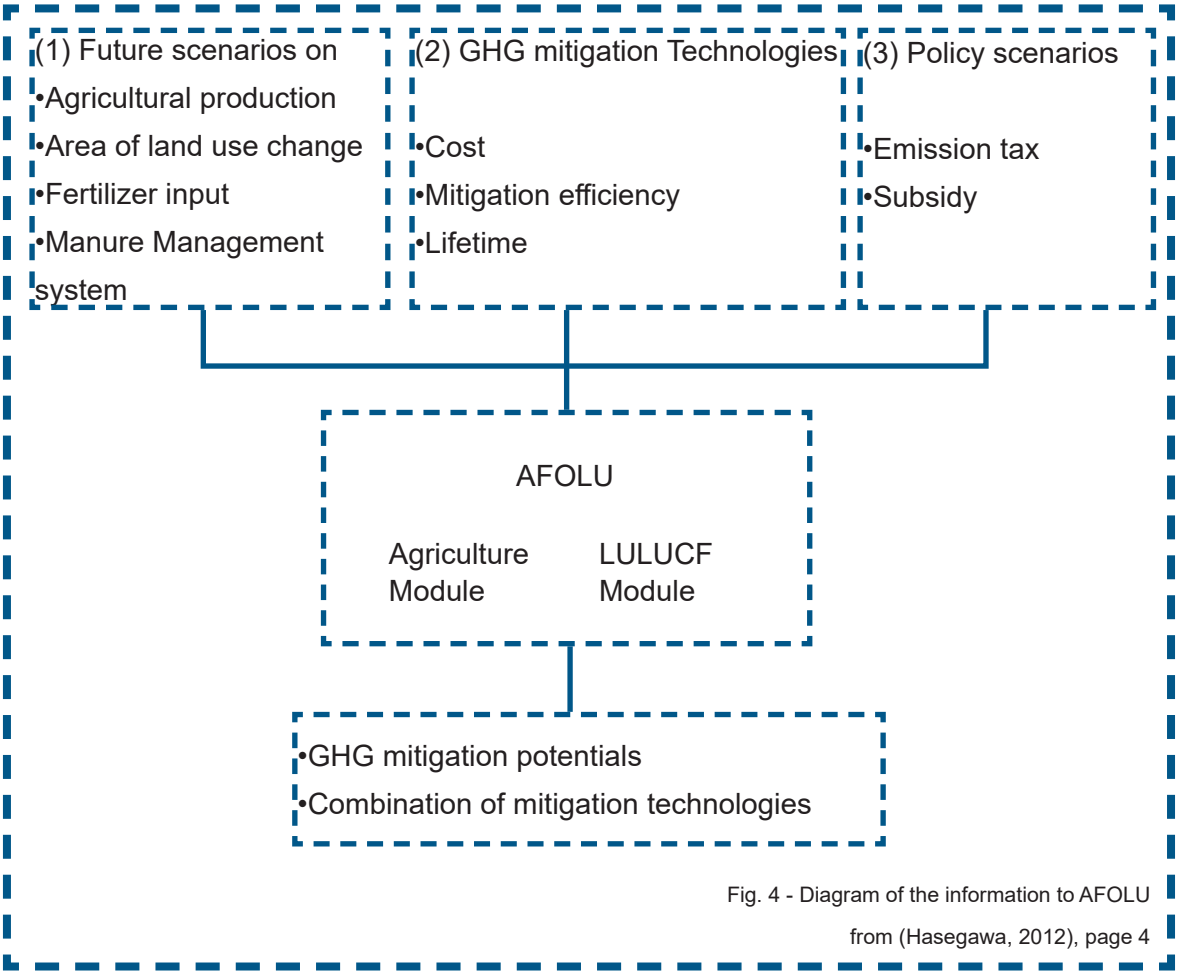


Fig. 4 - Diagram of the information to AFOLU from (Hasegawa, 2012), page 4

All these methods are used after gathering information about the land uses and the human behavior in the area to lower the carbon emissions as a way to evaluate the CO_2 emissions that happened in the base year.

These methods are the ones used in the bibliography consulted (Dai Qing and Matsuoka, 2017; Balkissoon, 2017; Hasegawa, 2012), and reference in others studies, to change a society to a low carbon society, having this into account the first and third method will be applied to this study in order to have a better evaluation of the CO_2 emissions by land use. With the implementation, each of these tree methods the aim is to achieve a low carbon society with a better landscape and healthier environment.

Chapter 2 – Low Carbon Society – Guidelines to become a Low Carbon Society

In this chapter was created a list using the legend of the "Map of Land Uses", 2007 from the Portuguese Geographic Institute (2007), which is based in the European CORINE *Land Cover*[2]. This map came to substituted the previous map from 1990, and intends to characterize with great detail the land cover / land use of continental Portugal. The nomenclature use in this study was chosen due to the great similarity of existing land uses in Portugal and Catalonia.

This list of land uses was divide in main groups as Artificial constructions, Agriculture and agroforesty areas, Forests and natural and semi-natural environments, Wetlands, Water and Energy. Each of this main groups are divide in subgroups that increase the detail and so on until achieved the fourth subgroup and the more detail in the land use. Associated to each of these subgroups (the more detailed) are delined actions to reduce the CO_2 emissions. These actions are the result and summarise all the measures available in the all the bibliography consulted during the internship about Low Carbon Societies and reduction of CO_2 emissions. (Apec, 2015; Vilén and Fernandes, 2011; Zhang et al., 2003; Shaheen and Lipman,2007; Walsh et al.,2017; Reid et al.,2004; Rogiers et al.,2008) The column about the percentage of potential Carbon reduction have into account the European targets to 2050 about CO_2 emissions in the different sectors, and the potentialities of each measure based in the results present in the reports of the different countries that ratified the Paris Agreement.

The calculation of the percentage of potential reduction of CO_2 emissions for each measure require data that wasn't available in the time line to the elaboration of this study, so the percentage is calculated in function of the data available in the articles consulted.

Land Uses	Percentage of potential Carbon reduction
Urban construction	30/40%
Industry	40%
Transportation	25%
Urban green spaces and Historical areas	10%
Agricultural and agroforestry	23%
Forest	10%
Wetlands	5%
Water	5%
Energy non renewables	80%

Table 2 – Percentage of potencial reduction of CO_2 emissions

From studies in the bibliography

[2] Although during the internship was publish the COS 2010, due to the state of the work and the small changes to the nomenclature, was choosen to keep the COS 2007.

Land uses				Measures to reduce emissions
Artificial construction				
	Urban construction			
				Using climate-smart products following a cascading principle, including increased use of wood in construction Restore degraded lands The total area of open spaces (AOS) in comparison with the total area of building blocks (ABB).The ratio of AOS/ABB is as more as more beneficial The green areas and water surfaces against the dry urban areas. Green and water surfaces have a positive impact to reduce the air temperature and carbon dioxide emissions The climate situation according to the climate zones. The moderate climate zones required less energy used for air conditioning and water heating. Population density (less is better) in terms of decreases the amount of carbon emissions. The land use distribution of the city sectors and the situation of energy resources which are related with the distance of carrying power to the building stocks. The orientation of the urban form which involves the paths and the building blocks in order to gain the most benefit from the natural environment. The vertical urban forms are more efficient than the horizontals in terms of energy used namely for cooling and heating demands where total area of roofs is less. bioswales, bioretention planters, rain gardens, check dams and green gutters. Green spaces and street trees Connection between urban areas with green spaces and ecological transportation

Land uses				Measures to reduce emissions
	Industry, trade and transportation			
		Industry, trade and equipments	Industry	The ratio of all industrial activities in the city to the other sectors (less is better)
			Trade	Improve local trade Avoid long distant transportation
			Agricultural installations	Implement new technologies
			Public and private equipment	Isolation in the equipment
			Energy production infrastructures	Implement new technologies Use only the necessary machinery
			Infrastructures for the abstraction, treatment and supply of drinking water	Implement new technologies
			Infrastructure for waste and waste water treatment	Rebuild to green structures of the end of life infrastructures
		Road and rail network and associated spaces	Road network and associated spaces	The careful consideration of road network expansion so as to conserve and promote natural habitats, ecological corridors and water systems, and prevent erosion and flooding Crossing points for animals Green corridors connecting the greens areas Investing in modern vehicles The accessibility where transportation could access across the central and the downtown zones easily with less congestion nodes.
			rail network and associated spaces	Electric trains powered by renewable energy
		Port areas		Use of minimal machinery Improve the quality of the machinery

Land uses				Measures to reduce emissions
	Areas of inert extraction, waste disposal sites and construction sites			
		Areas of inert extraction		Nature and location of works that will occur within 50 metres of a natural waterway or other sensitive environmental area Keep land clearance to a minimum. Avoid wherever possible clearing areas of highly erodible soils and steep slopes which are prone to water and wind erosion. Revegetate and mulch progressively as each section of works is completed. The interval between clearing and revegetation should be kept to an absolute minimum. Coordinate work schedules, if more than one contractor is working on a site, so that there are no delays in construction activities resulting in disturbed land remaining destabilised.
		Waste disposal sites	Landfills	Recuperate landfills site by transforming in parks
		Construction sites	Construction sites	Choosing the right machinery for the right task (for example avoiding inefficiently over-sized machines) The construction age, materials and the techniques used in the building blocks such as using isolation and double glazing to reduce the different in temperature between inside and outside the buildings.
	Urban green spaces, sports, cultural and leisure facilities, and historical areas			
		Urban green spaces	Parks and gardens	Use of long duration species Management of irrigation avoiding loss
			Graveyard	Input vegetation
		Sport facilities	Golf camps	Incorporate zones of hydrological and watershed importance into master-plans and site layouts Adopt a 'natural systems engineering' approach for drainage and storm water management Adopt a landscape planting strategy that is based entirely on drought tolerant trees and shrubs
		Leisure facilities	Camping sites	Integrated in nature Use of renewable energies
		Cultural facilities and historical areas		Enrich the cultural landscape Keep and promote cultural diversity, and ecological awareness should run through the development of human settlements, construction and maintenance

Land uses				Measures to reduce emissions
Agricultural and agroforestry areas				
				Only agricultural production technologies that have potentials to reduce the emission of GHG should be adopted in crop production. Sustainable development cultures in agriculture should be given priority and agriculture should not be seen as “business as usual” Government should be proactive in their policies to be ready for ecological challenges that occur mostly unplanned. Ecological funds should be raised as the magnitude of ecological disasters is usually not certain and difficult to control.
	Temporary crops			
				0 km program - consume of the local products Use of non artificial fertilizers
		Irrigation crops	Irrigation crops	Control in the use of the water Plantations according to soil type and climatic conditions Use of machinery to the minimal
		Rainfel crops	Rainfel crops	Plantations according to soil type and climatic conditions Use of machinery to the minimal
	Permanent crops			
				0 km program - consume of the local products Plantations according to soil type and climatic conditions Use of machinery to the minimal
	Permanent pasture			
				Management of irrigation avoiding loss
	Livestock			
				Consume of natural pastures or pastures of "non fertile" soil Balancing dietary proteins and feed supplements

Land uses				Measures to reduce emissions
Forests and natural and semi-natural environments				
	Forest			
				Increasing the forest area Planting new forest Increasing the carbon density/stock in forests Optimizing the use of appropriate irrigation Managing impacts of forest disturbances Maintaining forest area and site -and landscape - scale carbon stocks/density Preventing forest loss Suppressing forest disturbance via better management of fires, pest and diseases
	Open forest, shrub and herbaceous vegetation			
		Woods	Dense woods	Cleaning woods Use of waste to make power
			Little thick dense woods	Cleaning woods
		Open forests		Management
	Discovered areas and with little vegetation			
		Beaches and dunes		Keep clean and with the typical fauna and flora
		Burned areas		Ecosystems restoration Reforestation
Wetlands				
	Inner wetlands			
				Conservation of these spaces stooping the change in land use
	Coastal wetlands			
				Conservation of these spaces stooping the changes in land use

Land Uses				Measures to reduce emissions
Water				
	Inner water			
				Exploited water sources should be taken from river basin of the region
		Water lines	Natural water lines	Preservation of clean water Use of water lines to irrigation of crops
		water plans	Lakes	Keep the water not polluted
			Reservoirs of dams	Keep the water not polluted Generate renewable energy
	Marine and coastal waters			
		Coastal lagoons		Keep the water not polluted
		Ocean		Produce electric power
		Sea		Produce electric power
Energy				
	Energy supply (non renewable)			
				Using sustainably produced wood products and residues for energy Optimize energy utility Release low energy consumption, and the use of renewable energy, local energy products and resources recycling technologies.
		Oil		Reduce the use to de minimal
		Gas		Reduce the use to de minimal
		Coal		Reduce the use to de minimal
		Nuclear		Reduce the use to de minimal
	Energy supply (re-newable)			
				Use of Biogas plants near animal farms
		Solar		Implementation in public equipments
		Wood		Use Forest waste

Table 3 – Measures to reduce CO_2 emissions

From studies in the bibliography

Chapter 3 - Landscape policies in Catalonia

Landscape policies, in Catalonia, were introduced through the Resolution 364/VI of the Parliament of Catalonia, 14th of December 2000, when the Government of Catalonia officially agreed to implement the European Landscape Convention, two months after the sign of the treaty by the Spanish Government (20/10/2000; Europe, 2017) that was preceded by the approval in the Council of Europe.

The European Landscape Convention was the first international treaty to deal with the landscape itself and its purpose is to promote conservation and improve the extraordinary diversity of European landscapes (Nogué; Sala; Grau, 2016).

The European Landscape Convention brings a new perspective to European landscape, as an official treaty ratified by European countries with equal objectives. With this the European landscape can be planed and manageable as a whole, going beyond borders or qualities of the landscape. This treaty mentions the different types of landscape, having all the countries that ratified the treaty to implement news laws to improve and manage these landscapes, whether they are urban, rural, periurban or natural, whether they are outstanding, everyday or degraded areas.

The Government of Catalonia approved the Law 8/2005, 8th of June on protection, management and planning of the landscape and the Decree 343/2006, 19th of September that develops it, in order to implement the European Landscape Convention. It was even ratified before the Spanish Government which only applied in 2007 (26/11/2007). With this law (Law 8/2005) was created the Landscape Observatory of Catalonia as the institution responsible to the protection, management and study of the Catalan landscape.

3.1 – Landscape Observatory of Catalonia and the news landscape laws

After the ratification of the European Landscape Convention by the Catalan Council (December of 2000), the first step was the creation of the Landscape Observatory of Catalonia in 2004, followed by the creation of the Law 8/2005, of 8th of June, about protection, management and planning of landscape, and the Decree 343/2006, that developed into a regulation. This law and this decree translates the principles of the European Landscape Convention in all sense.

"*The Observatory has a significant ability to generate knowledge and to create synergies, complicities and interdependences from proximity and from everyday experience. Therefore, it is a centre that seeks to influence the definition and design of future tendencies, and that acts as a large umbrella under which anyone interested in the landscape can take refuge*." (Nogué; Sala; Grau, 2016).

Knowledge of the landscape is the base to the creation and implementation of landscape laws, for that reason the Observatory started the mapping of the Catalan landscape with the creation of the landscape units, landscape catalogues and landscape charters (tools created by the Law 8/2005 and implemented by the Observatory), tools that are used to the identification and mapping of the landscape as well as the evaluation and management.

3.2 - Landscape Catalogues

The Landscape Catalogues are inspired by parts c) and d) of the article 6 of the European Landscape Convention, which is transcribed below (Table 4):

Article 6 – Specific measures (Council of Europe, 2000)

c) Identification and assessment

1. With the active participation of the interested parties, as stipulated in Article 5.c, and with a view to improving knowledge of its landscapes, each Party undertakes:

a) i) to identify its own landscapes throughout its territory;

ii) to analyse their characteristics and the forces and pressures transforming them;

iii) to take note of changes;

b) to assess the landscapes thus identified, taking into account the particular values assigned to them by the interested parties and the population concerned.

2. These identification and assessment procedures shall be guided by the exchanges of experience and methodology, organised between the Parties at European level pursuant to Article 8.

d) Landscape quality objectives

Each Party undertakes to define landscape quality objectives for the landscapes identified and assessed, after public consultation in accordance with Article 5.c.

Table 4 – Article 6 of the European Landscape Convention

From Council of Europe, 2000

The Landscape Catalogues lie in their final objective and their integration in the approval process of the partial territorial plans. *"The landscape catalogues are the tools that enable us to get to know what our landscape is like and what values it has, witch factors explain why we have one certain type of landscapes and not another one, how our landscapes evolve in keeping with current economic, social and environmental dynamics and, finally, will define what type of landscape we wish to have and how we can achieve it."* (Nogué; Sala; Grau, 2016).

The catalogues provide information of great importance about all Catalan landscape, their existing values and the ones that could be enhance, contributing to the definition and application of the landscape policies that should count whit the cooperation and participation of all social stakeholders that intervene in the territory.

The European Landscape Convention defines landscape as *"an area, as it is perceived by people, whose character is the results of the interaction of natural and/or human factors"*

(Council of Europe, 2000). Integrating this vision that combines the natural and cultural components, the landscape catalogues assume this definition (the European Landscape Convention), but at the same time define landscape as perceived in a physical reality and according to the representation that we make of it. (Nogué; Sala; Grau, 2016). The following Table 5 describes the information that should be find in a Landscape Catalogue (Nogué; Sala; Grau, 2016):

The Landscape Catalogue: (Nogué; Sala; Grau, 2016).

- Provide information of great interest on all the Catalan landscape and create awareness in matters of landscape.
- Are support tools to the introduction of landscape in territorial and urban planning, and to sectorial policies.
- Are based on an integrated vision of landscape that takes the natural and cultural components jointly, never separately.
- Are based on the existence of diverse landscape values attributed by the stakeholders who intervene and by the population who enjoy them.
- Are applies to the Catalan territory, as a whole, and not just to unique or exceptional spaces.
- Integrated public participation as a tool for involving and giving shared responsibility to society in the management and planning of their landscape.
- Are rigorous from a scientific point of view but use language that is not over technocratic.

Table 5 – Function of the Landscapes Catalogues of Catalonia
From The Landscape Catalogues of Catalonia Methodology, Nogué; Sala; Grau, 2016

The creation of the catalogues had the collaboration of the society, that was present in the identification and nomenclature of every landscape unit, creating a link between the population and the instruments of landscape identification. The catalogues were conceived as tools with the intent to plan and manage the landscape from a spatial planning perspective, for that reason the territorial reach corresponds to the administrative division present in Partial Territorial Plans of 2005.

The landscape of Catalonia is divided in seven catalogues: Alt Pirineu i Aran, Camp de Tarragona, Comarques Centrals, Comarques Gironines, Terres de Lleida, Regió Metropolitana de Barcelona, Terres de l'Ebre (Fig.5).

Map of the division of the Landscape Catalogues of Catalonia

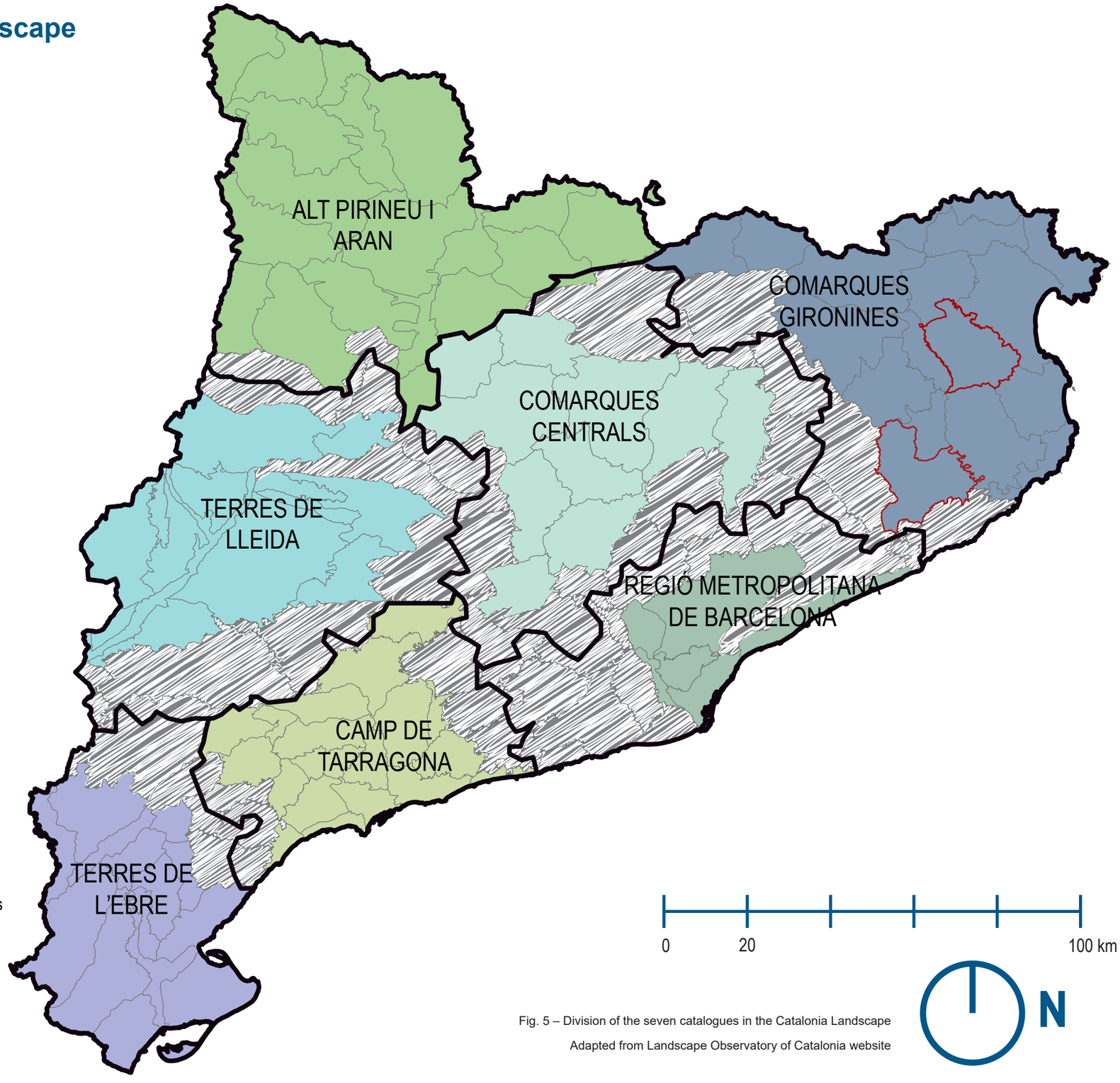


Fig. 5 – Division of the seven catalogues in the Catalonia Landscape

Adapted from Landscape Observatory of Catalonia website

The content necessary in the seven catalogues is established by the article 11 in the Law 8/2005 of 8th of June on protection, management and planning of the landscape. In every catalogue should be present the inventory of the landscape values, the enumeration of the activities and the processes that influence or have influenced most notably the current configuration, the mapping of the main routes and spaces as perceived, the delimitation of the Landscape Units, the definition of the Landscape Quality Objectives for each Landscape Unit and the proposal of measures and actions necessary to obtain the Landscape Quality Objectives.

The documents that each catalogue should contain are defined by the article 6 of the Decree 343/2006, of 19th of September as a complement of the previous law (8/2005 of 8th of June), this documents are reports of the diagnosis and assessments, landscape quality objectives, cartography, photographic archive, containing the current state and if possible the historic background, other studies that are considered appropriate depending on the specificities of each territorial area, database and links to elements likely to intervene as landscape elements (annex 1).

Each catalogue is divided in two volumes, the first one contains the analyze of the entire territorial area of the catalogue and the second contains a specific file for each of the landscape units. The content of this volumes can be found in annex 3.

3.3 – Landscape units

The Landscape Observatory of Catalonia defined Landscape Unit as the portion of the territory, with specific components from different nature (cultural, environmental, cultural, etc.), with recognizable dynamics that results in an individuality that differs from the rest (Catalonia, 2017).

In the volume II (annex 2) of each catalogue can be found the documents about each of the one hundred and thirty-four landscape units, the name of the landscape units is related with the most characterizing feature of the area, some of the units had their name changed after the public participation in the identification of the landscape characteristics. Every Landscape Unit has a unique feature that distinguish it from the surrounding landscapes with a unique history and mosaic. The politic limits aren't applied to the units, having some units cross the borders between the Partial territorial plans or even between countries (Fig 5 and 6).

Map of the Landscape Units of Catalonia

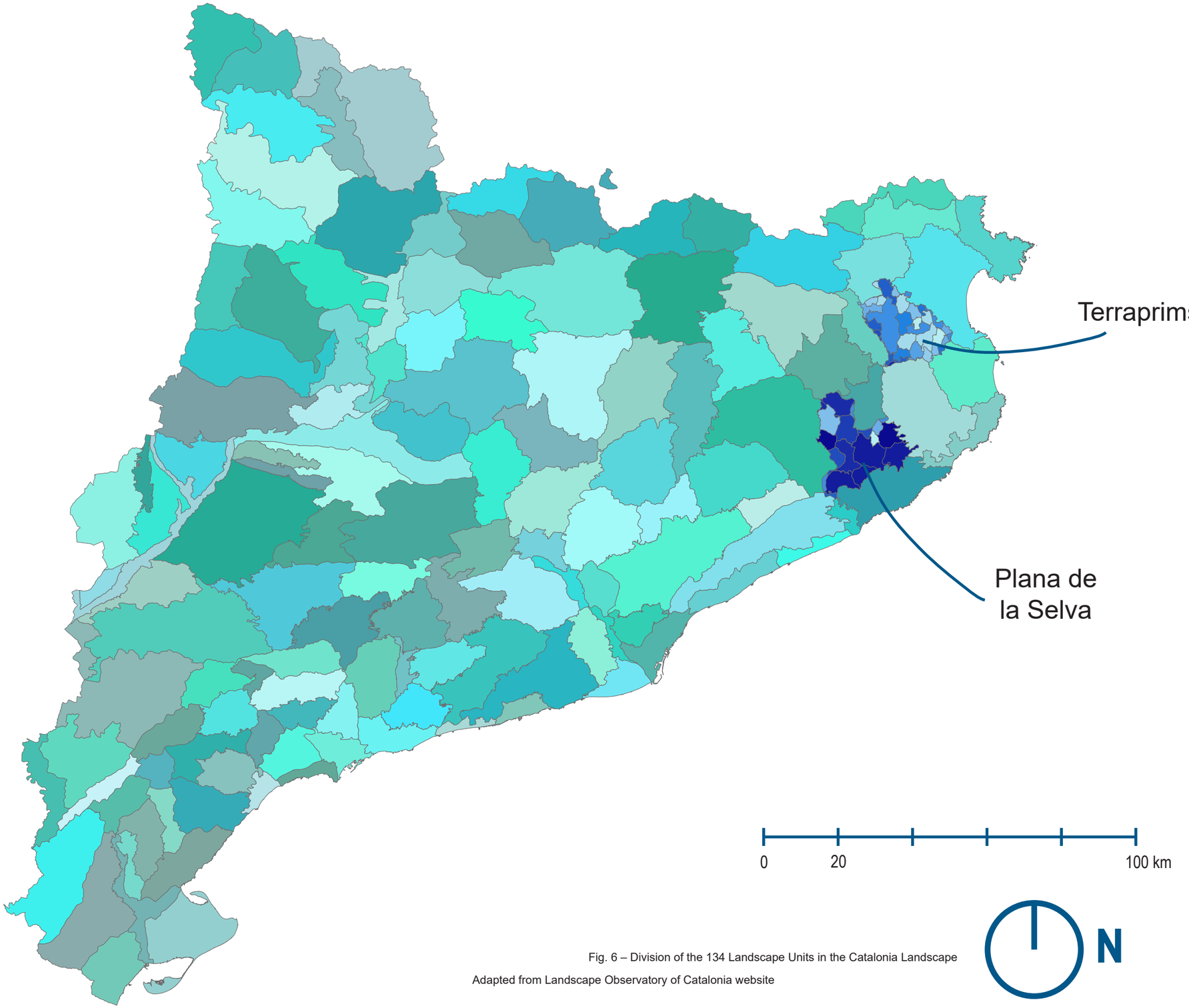


Fig. 6 – Division of the 134 Landscape Units in the Catalonia Landscape

Adapted from Landscape Observatory of Catalonia website

Chapter 4 - Case-studies - Comarques Gironines - Plana de la Selva and Terraprims

For this study, the Landscapes Units choosen are Terraprims and Plana de la Selva that belong to the Landscape Catalogue of Comarques Gironines, where is situated the city of Olot, local of the internship. Due to the proximity of these units to the local of the internship and the differences of the land uses between them, giving an opportunity to compare different proposals.

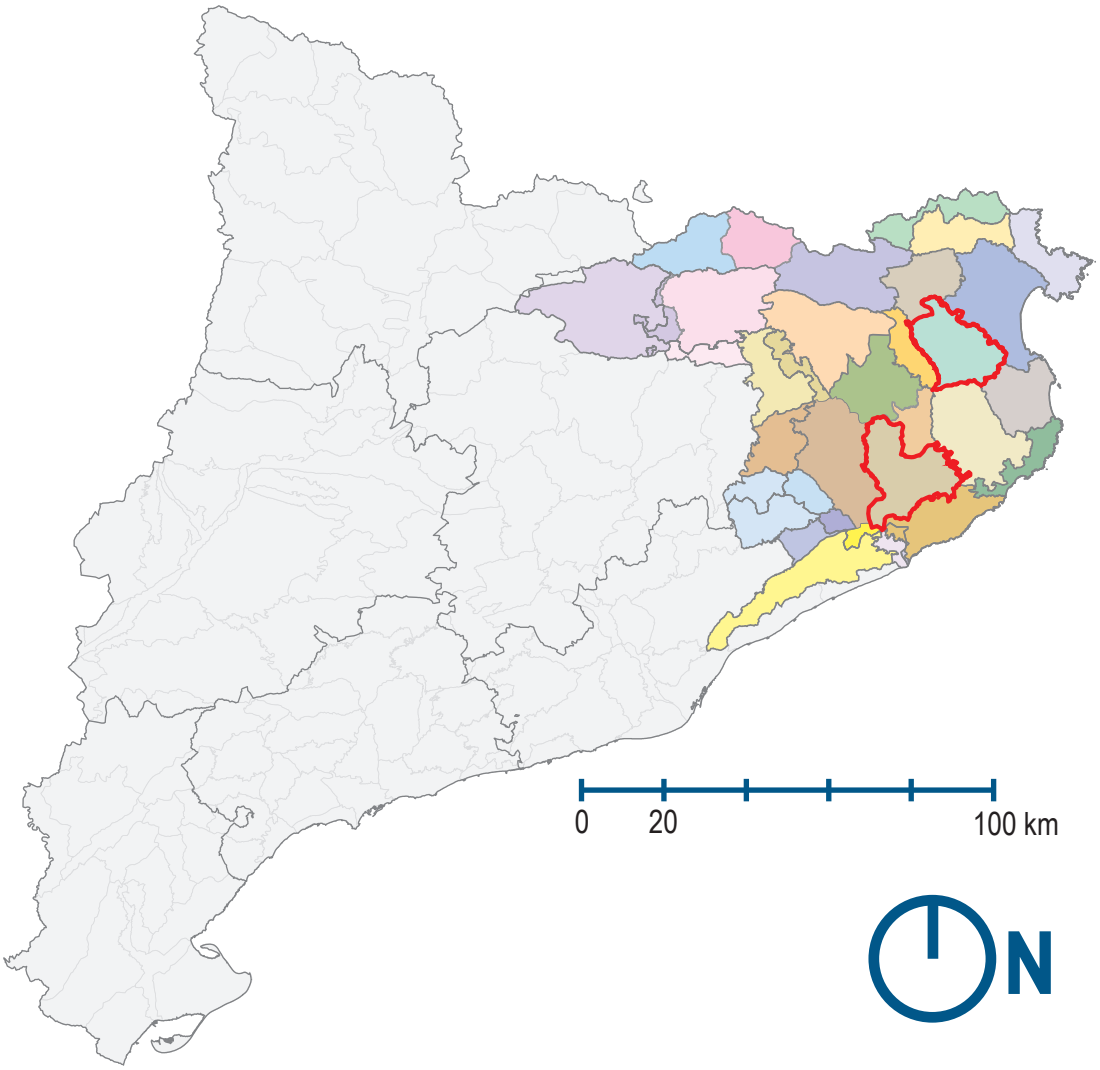


Fig. 7 – Landscape units in the Landscape Catalogue of Comarques Gironines in the map of Catalonia

Adapted from Landscape Observatory of Catalonia website

Fig. 8 – Landscape units in the Landscape Catalogue of Comarques Gironines

Adapted from Landscape Observatory of Catalonia website

The delimitation of the Landscapes Units is made true the defining characters that are different from all the other units, being a unique space define having into account all the characteristics of the area as well as the perception of the territory by the population that uses it.

This chapter try to give an inside perspective about the Landscape Units and major difference between the two of them. All the chapter is based in the final report of Landscape Observatory of Catalonia about the Landscape Units that are available in the official book, Landscape Catalogue – Comarques Gironines, and in the official website of the Landscape Observatory of Catalonia, all the information its only available in Catalan.

4.1- Plana de la Selva

Every Landscape Unit have unique features. In the case of Plana de la Selva the most evident ones are the slightly wavy plains place between the mountains of Gavarres, and the massif of l'Ardenya and Guilleries, where the agroforest landscape covers almost all the land. The Vulcans leave a singularity mark in all landscape extoling the landscape of La Crosa de Sant Dalmai, Maçanet, Caldes de Malavella and Santa Coloma de Farners. The presence of lagoons and wetland like the lake of Sils. The plantation of Platanus and Populus in the edges of water lines. The expansion of urbanization through the mountains and the interior. Industrials areas and services of airports and connections routs like AP-7, N-11 and trains lines. And finally, the farms and small groups of houses connected to the agroforestry landscape (Fig. 9).

Fig. 9 – Hill of Sant Jordi - Maçanet - Plana de la Selva

From Landscape Observatory of Catalonia

Map of aesthetic values of Plana de la Selva

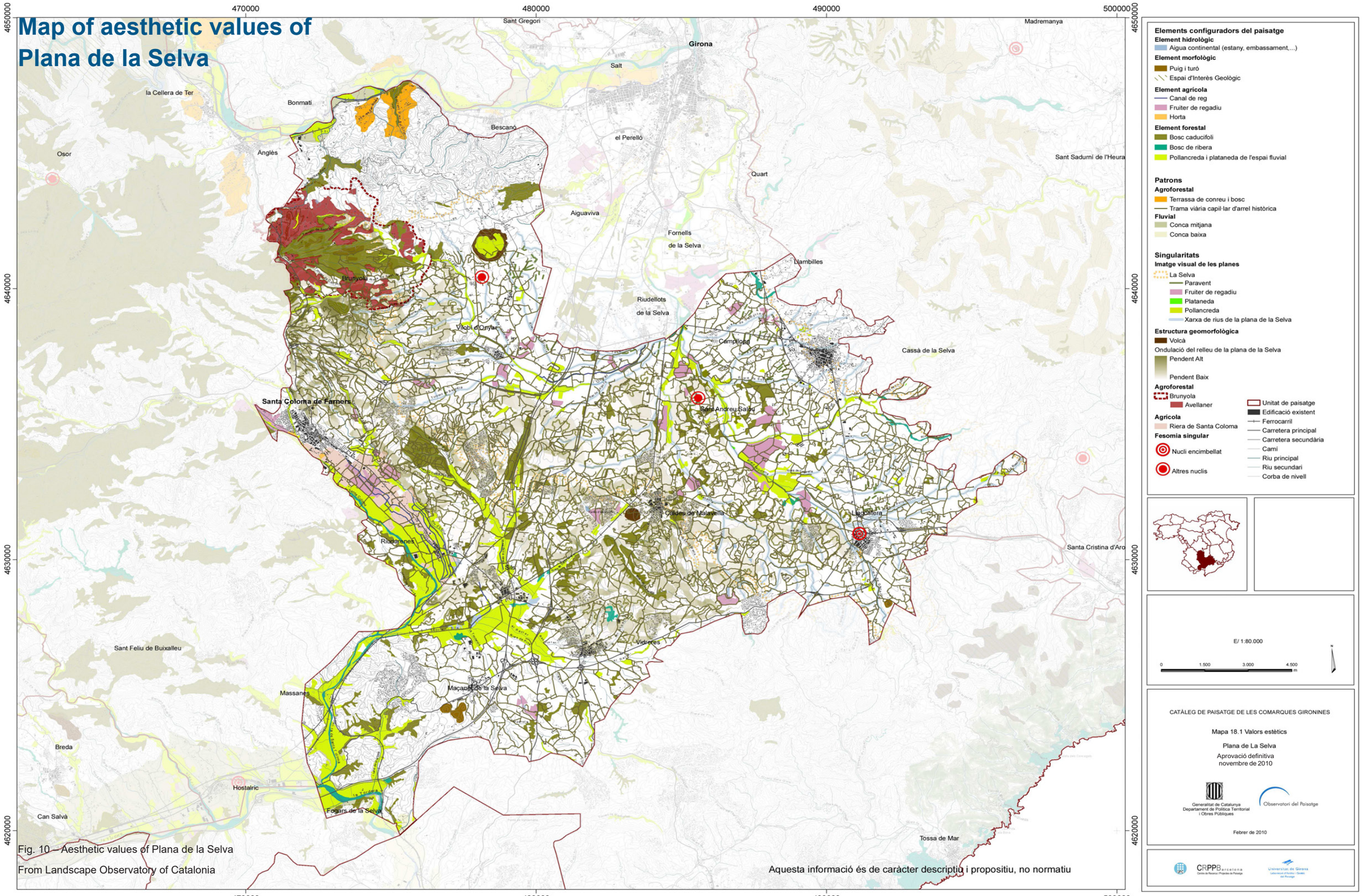


Fig. 10 – Aesthetic values of Plana de la Selva
From Landscape Observatory of Catalonia

Map of historical values of Plana de la Selva

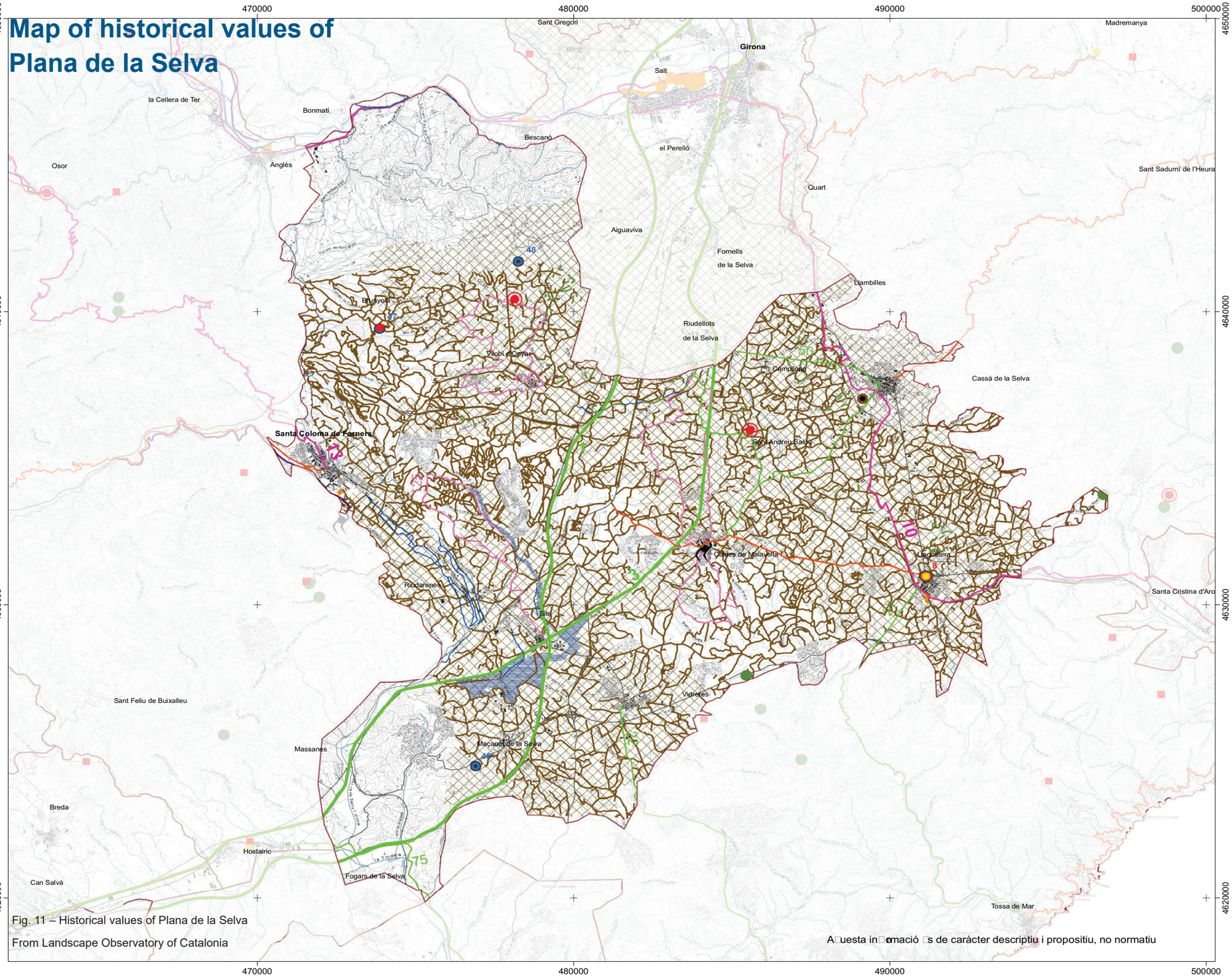


Fig. 11 – Historical values of Plana de la Selva

From Landscape Observatory of Catalonia

Aquesta informació és de caràcter descriptiu i propositiu, no normatiu

4.1.1 - Organization and dynamic of the landscape

Since the medieval ages the landscape in Plana de la Selva is mostly agrarian, only in the twentieth century start appearing the firsts signs of landscape changes, like urban expansion, connections routs and train lines. In the head of the Onyar can be characterize as a mosaic of crops mostly of *Corilus avelana* and herbaceous alignments, between some plantations of *Quercus* spp. and other caducifolious trees. Abundance of farms and small villages spread through the landscape.

Changes in the landscape: construction and amplification of the transport infrastructures, urban growth, abandonment of agriculture fields and new economic activities. The biggest infrastructure changing the landscape is the train line for high velocity (TAV), having a visual impact and fragmenting the landscape. The abandonment fields evolve to forest near the habitation areas, existing a bigger risk of fires.

Fig. 12 – Maçanet de la Selva from Torcafelló Castle - Plana de la Selva 1

From Landscape Observatory of Catalonia

4.1.2 - Values of the landscape

The natural and ecological values of Plana de la Selva are connected with the Vulcans and the characteristic houses from wet areas. The Vulcan from Crosa de Sant Dalmai and the volcanic columns of Maçanet protected by the PEIN (Plan for Areas of Natural Interest).

Fig. 13 – Vulcan Crosa de Sant Dalmai - Plana de la Selva

From Google Earth

Fig. 14 – Maçanet de la Selva from Torcafelló Castle - Plana de la Selva 2

From Landscape Observatory of Catalonia

4.1.3 - SWOT analysis

This SWOT analysis is based in the SWOT made by the Landscape Observatory of Catalonia, available in Catalan in the Landscape Catalogue available in the official website of the Observatory.

Strengths	Weakness
- Places with great ecological value - Rotation of the crops that changes between them in a harmonic way - Organization that manage the areas of swamp, improving this places in a ecological way, teaching and informing the population about this places.	- Fragmented and fragile landscape, from consequence of alteration in the land uses through the time. - News urbanization without connecting with the existing landscape and land uses, fragmentation of the mosaic.
Opportunities	**Threats**
- Several places with natural value use as resource for rural development and environmental education. - A new common agricultural policy (CAP) with environmental applications and integration of quality products, reducing the serial production and the homogenise of the agricultural landscape.	- The construction of streets and highways all over the unit without having in account the visual impact. - The construction of new equipment for economic activities thought the roads, increasing the fragmentation of the landscape.

Table 6 – SWOT analysis to Plana de la Selva

Based in the SWOT analysis available in the Landscape Catalogue of Comarques Gironines from the Landscape Observatory of Catalonia

Fig. 15 – Llagostera - Plana de la Selva
From Landscape Observatory of Catalonia

4.1.4 - Land Use Evolution

The Landscape Units are in constant change. Land use gives a better perception of these changes and the maps use in this chapter are adaptation of the information available in the CREAF website, that facilitates this information through the years. The maps use is relative to the years of 2005 and 2009, year of the beginning of the mapping of the Landscapes Units and previous year of its approval (the final edition at 30th November 2010 on a resolution from the director general of Architecture and Landscape giving definitive approval for the Landscape Catalogue of the Comarques Gironines). All the data use are official data obtain from the official websites of Catalonia.

In the study of evolution of the land use, the data is referent to 2005 and not to an earlier year because this information wasn't available in vector and having into account the time table to this work wasn't able to vectorization of previous years.

Map of the Forestal Land Uses in 2005 of Plana de la Selva

Legend

- Clear forests (not from riverside)
- Clear riverside forests
- Dense forests (not from riverside)
- Dense riverside forests
- Forests of protection
- Shrubs
- Shrubs - Forests cut everywhere
- Eucalyptus plantations
- Plantations of non-autochthonous conifers
- Plantations of Platanus
- Plantations of Populus
- Meadows and pastures
- Meadows and pastures - forests cut everywhere
- Forest knot floors
- Vegetation of continental wetlands

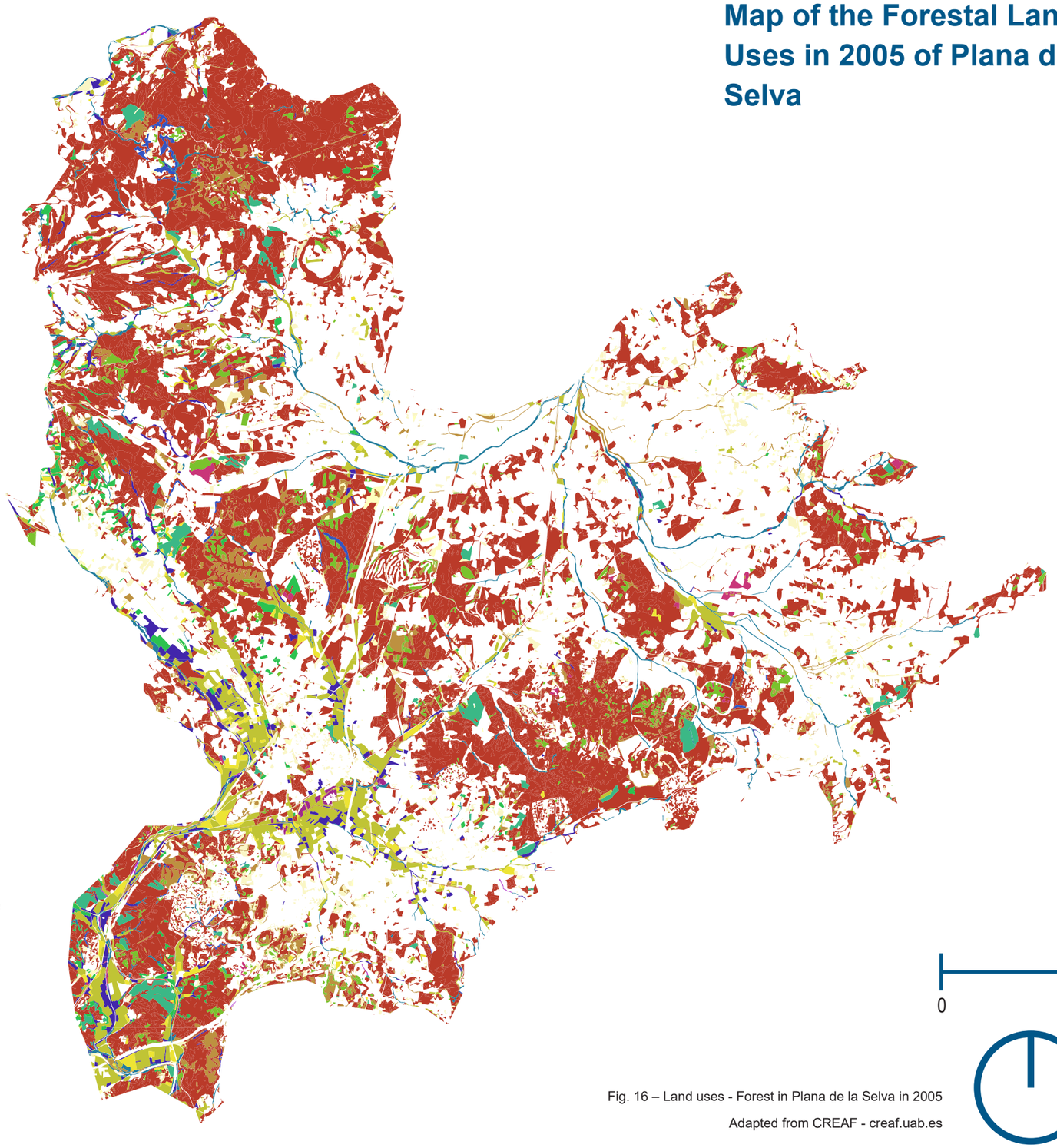


Fig. 16 – Land uses - Forest in Plana de la Selva in 2005

Adapted from CREAF - creaf.uab.es

Map of the Land Uses in 2009 of Plana de la Selva

Legend

- Clear forests (not from riverside)
- Clear riverside forests
- Dense forests (not from riverside)
- Dense riverside forests
- Forests of protection
- Shrubs
- Shrubs - Forests cut everywhere
- Eucalyptus plantations
- Plantations of non-autochthonous conifers
- Plantations of Platanus
- Plantations of Populus
- Meadows and pastures
- Meadows and pastures - forests cut everywhere
- Forest knot floors
- Vegetation of continental wetlands
- Burned areas

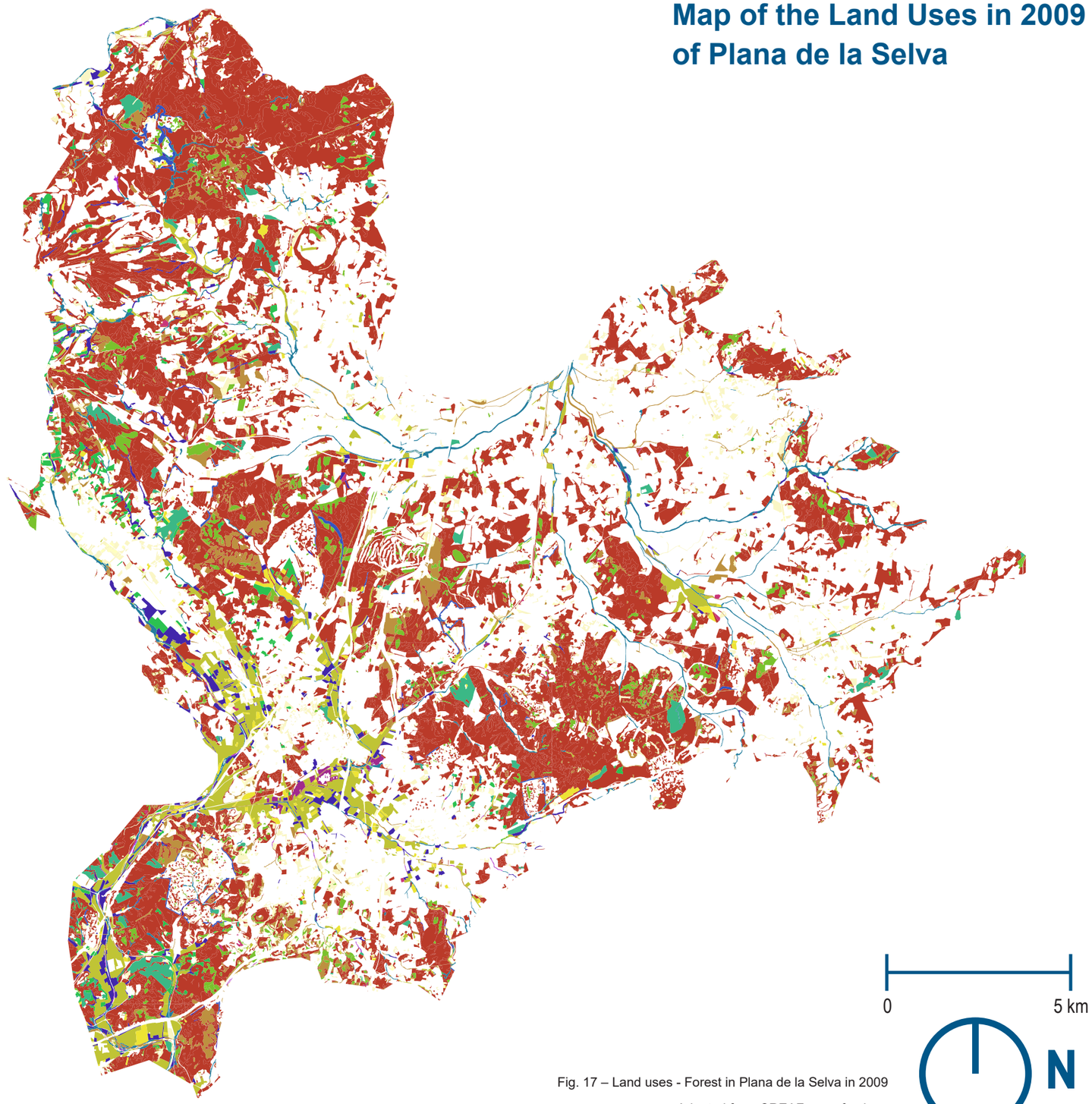


Fig. 17 – Land uses - Forest in Plana de la Selva in 2009

Adapted from CREAF - creaf.uab.es

Map of the Urban Land Uses in 2005 of Plana de la Selva

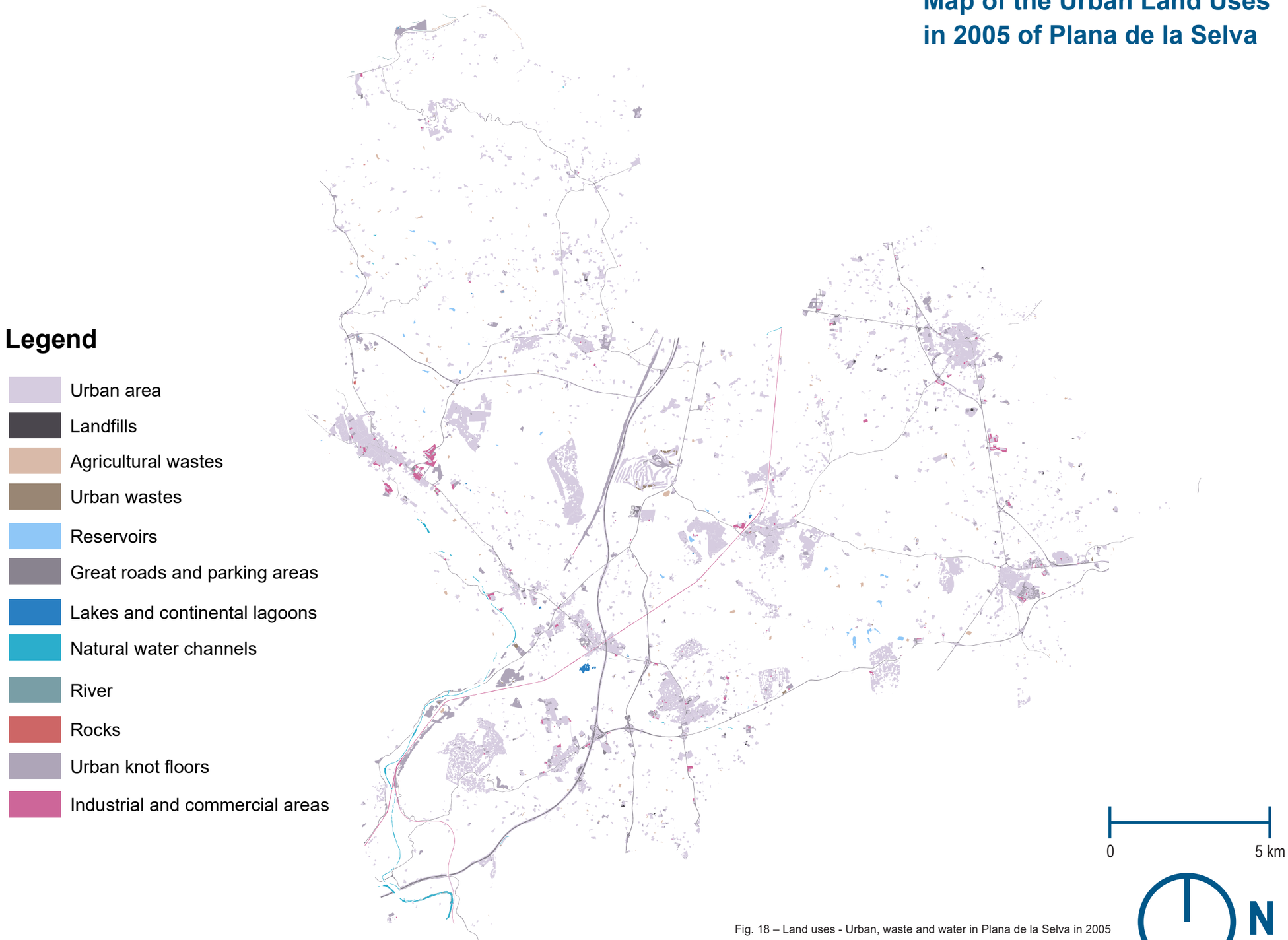


Fig. 18 – Land uses - Urban, waste and water in Plana de la Selva in 2005

Adapted from CREAF - creaf.uab.es

Map of the Urban Land Uses in 2009 of Plana de la Selva

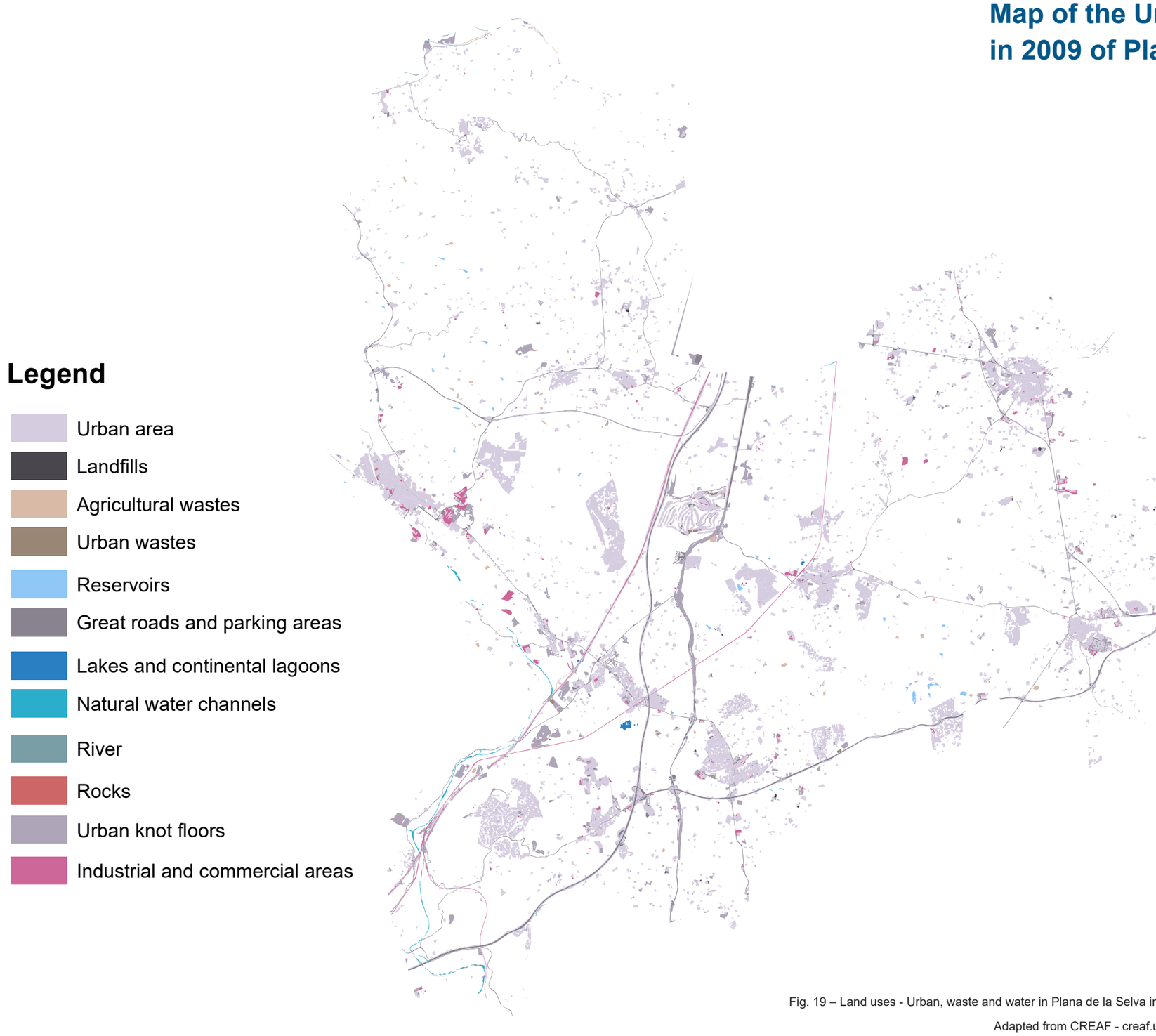
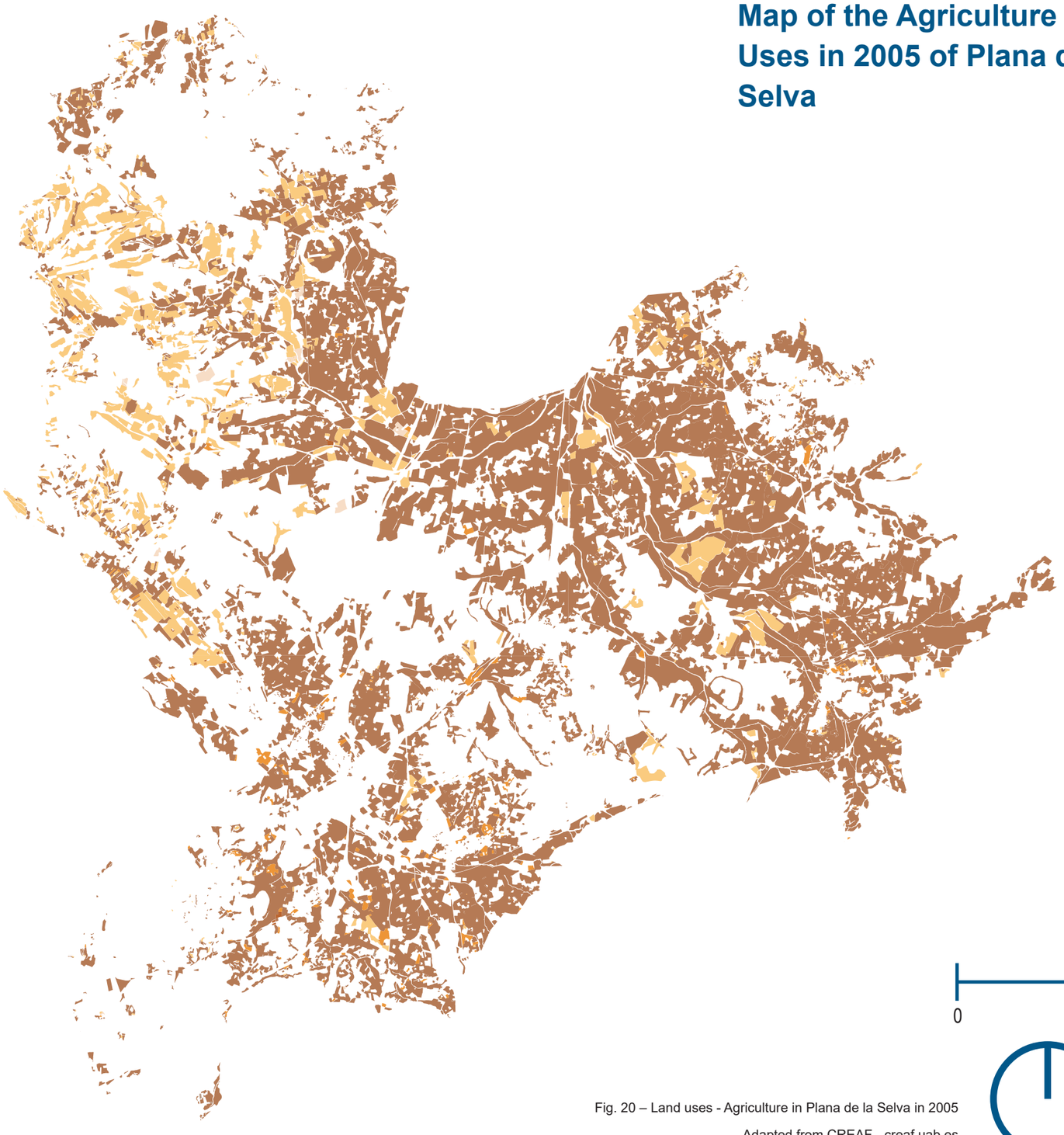


Fig. 19 – Land uses - Urban, waste and water in Plana de la Selva in 2009

Adapted from CREAF - creaf.uab.es

Map of the Agriculture Land Uses in 2005 of Plana de la Selva



Legend

- Abandoned crops - meadows
- Crops in tranformation
- Herbaceous crops (non-arresting)
- Woodland crops (not vineyards)
- Greenhouses
- Vineyards

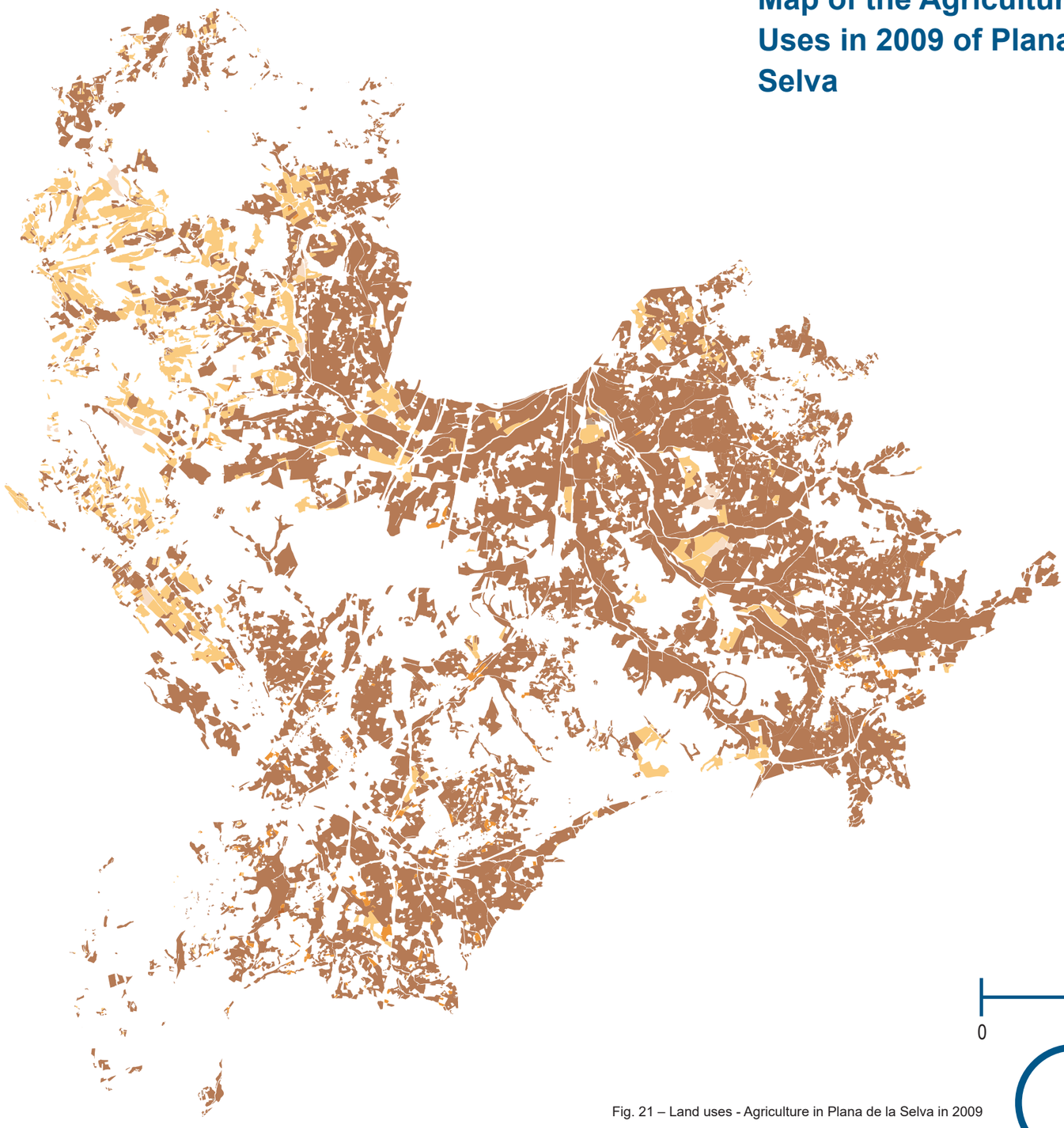
0 5 km

N

Fig. 20 – Land uses - Agriculture in Plana de la Selva in 2005

Adapted from CREAF - creaf.uab.es

Map of the Agriculture Land Uses in 2009 of Plana de la Selva



Legend

- Abandoned crops - meadows
- Crops in tranformation
- Herbaceous crops (non-arresting)
- Woodland crops (not vineyards)
- Greenhouses
- Vineyards

0 5 km

N

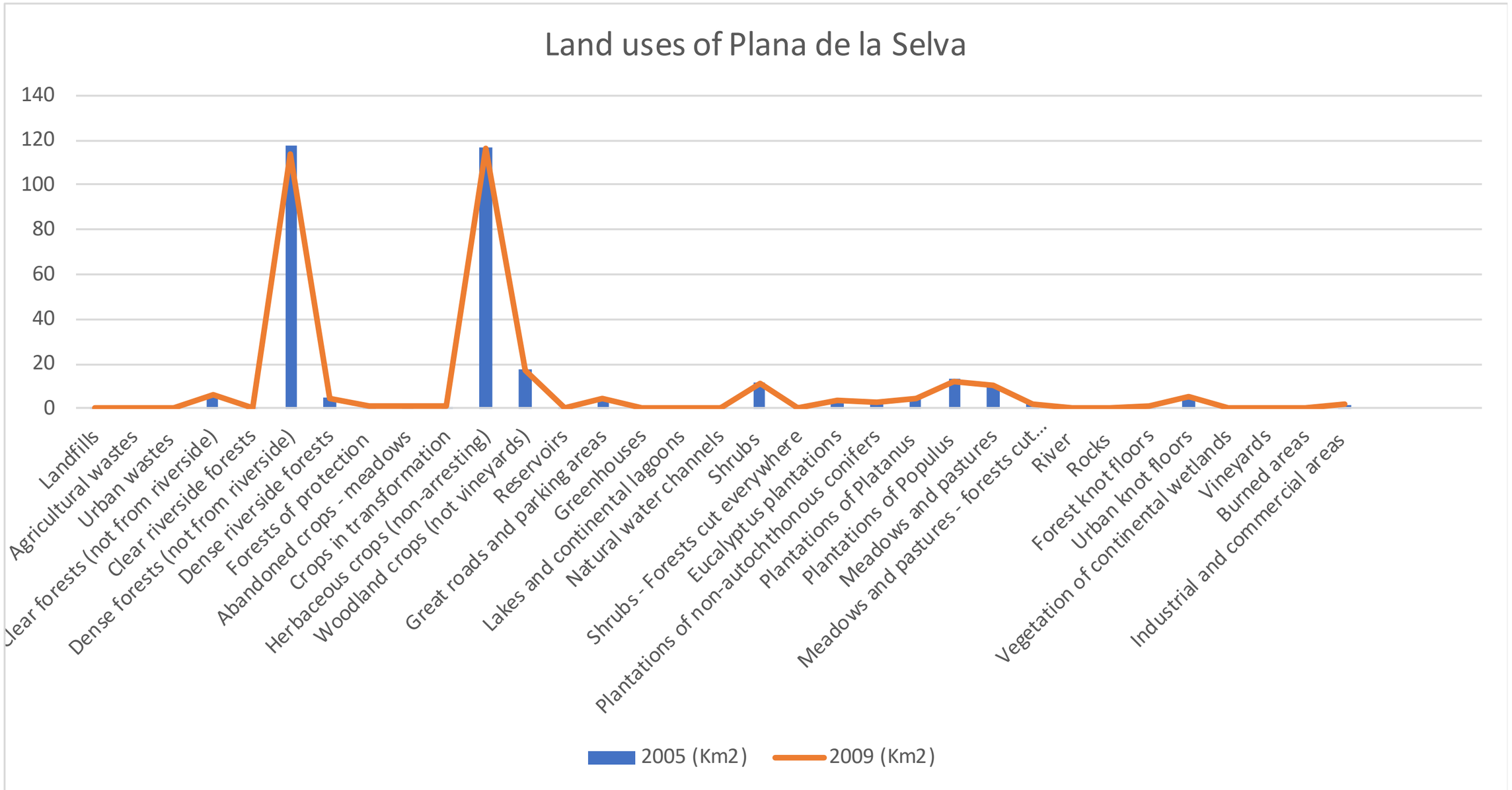
Fig. 21 – Land uses - Agriculture in Plana de la Selva in 2009

Adapted from CREAF - creaf.uab.es

Land uses	2005 (Km^2)	2009 (Km^2)	
Landfills	0,058	0,073	
Agricultural wastes	0,48	0,50	
Urban wastes	0,12	0,13	
Clear forests (not from riverside)	5,05	6,37	
Clear riverside forests	0,085	0,134	
Dense forests (not from riverside)	117,33	114,02	
Dense riverside forests	4,60	4,53	
Forests of protection	0,69	1,01	
Abandoned crops - meadows	1,82	1,49	↓
Crops in tranformation	0,45	0,96	
Herbaceous crops (non-arresting)	116,99	116,68	
Woodland crops (not vineyards)	17,79	17,12	
Reservoirs	0,22	0,19	
Great roads and parking areas	4,03	4,64	
Greenhouses	0,13	0,11	
Lakes and continental lagoons	0,079	0,078	
Natural water channels	0,34	0,26	
Shrubs	11,31	11,59	
Shrubs - Forests cut everywhere	0,72	0,29	↓
Eucalyptus plantations	4,14	3,87	↓
Plantations of non-autochthonous conifers	2,68	2,60	
Plantations of Platanus	4,28	4,18	
Plantations of Populus	12,99	11,96	↓
Meadows and pastures	10,15	10,56	
Meadows and pastures - forests cut everywhere	2,44	2,14	
River	0,051	0,069	
Rocks	0,009	0,009	
Forest knot floors	1,49	1,30	
Urban knot floors	4,49	5,06	↑
Vegetation of continental wetlands	0,19	0,29	
Vineyards	0,16	0,21	↑
Burned areas	0	0	
Industrial and commercial areas	1,15	1,76	

Table 7 – Area of each land use in Plana de la Selva in 2005 and 2009

Adapted from CREAF - creaf.uab.es



Graphic 1 – Graphic of the area of each land use in Plana de la Selva in 2005 and 2009

Adapted from CREAF - creaf.uab.es

In the Graphic 1 and Table 7 that compere the area of each land use in km^2 in 2005 to the area in 2009. The areas with major decrease in area are the Abandoned crops – meadows, Shrubs -forest cut everywhere and Plantation of Populus, and the major increases are of urban areas and waste disposal. The area of Crops transformation showing the tendency to change of the type of cultures.

4.2 - Terraprims

Terraprims is described as an extensive territory with evident rural character although the proximity to the urban areas of Girona - Banyoles and Costa Brava de l' Empordà. Relief constituted by a wavy terrain furrowed by torrents and tributary streams of the river Ter or Fluvià. The mosaic is compost by agroforestry landscape, mostly by cereals crops and plantations of *Pinus* spp. and *Quercus* spp. Near the Ter river the open plans have plantations of *Populus* sp. and *Platanus* sp. and cultivations of irrigations crops between Medinyà and Jafre. The connective function of the river Ter and Fluvià that cross the unit. The Villages are distributed across the unit in small spaces and surrounding the historical buildings as castles or churches. In the entrance of the village of Orfes the tree lines gave a distinct feature. The unit is divide in half longitudinally by a communication infrastructure.

Fig. 22 – Entrance of the Village of Vilademuls - Terraprims

From Tânia Azevedo

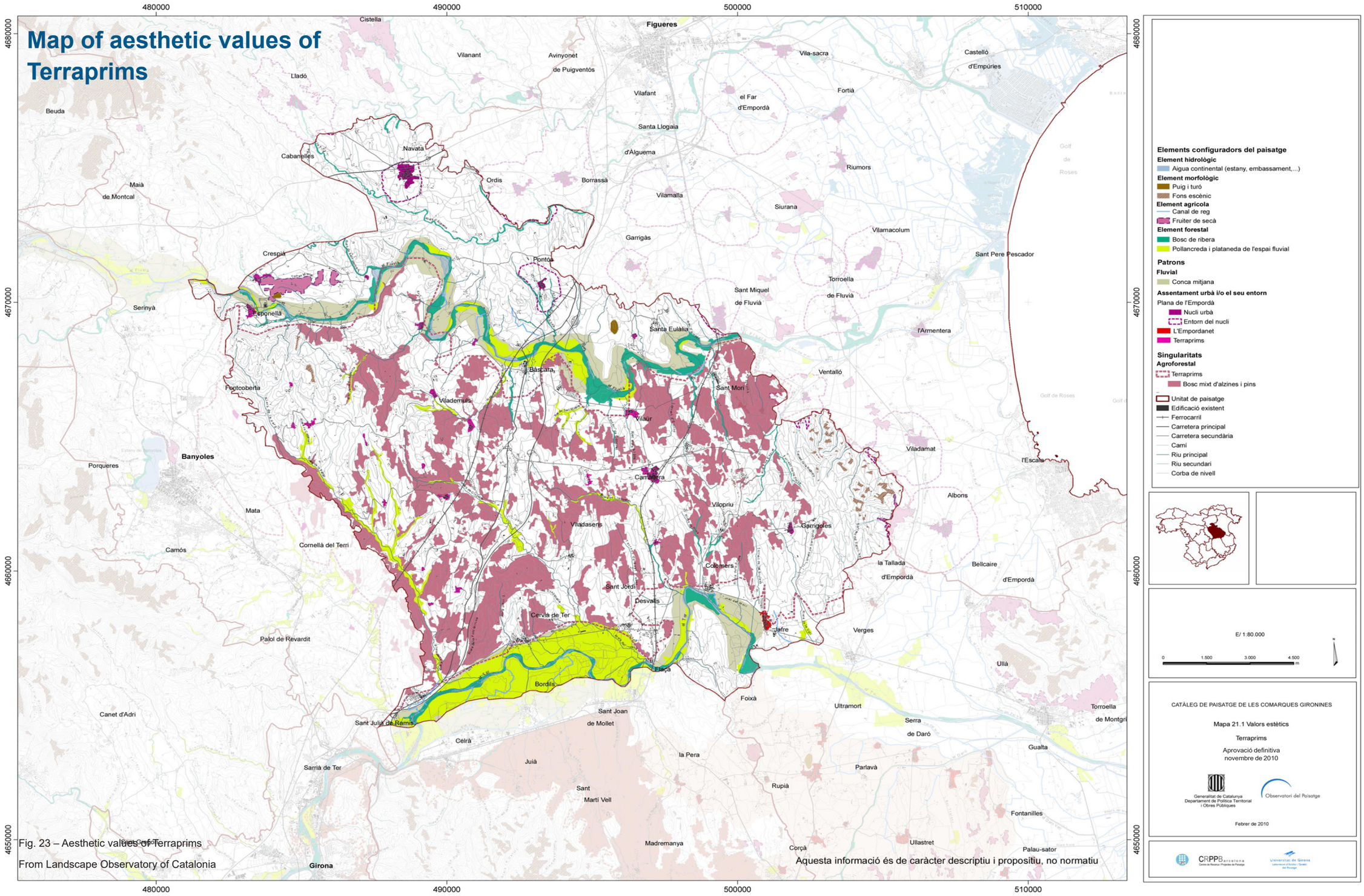


Fig. 23 – Aesthetic values of Terraprims

From Landscape Observatory of Catalonia

Map of historical values of Terraprims

480000 490000 500000 510000

4 80000 4 70000 4 60000 4 50000

Cistella Figueres Vilanant Avinyonet de Puigventós Vila-sacra Castelló d'Empúries Lladó Vilafant el Far d'Empordà Fortià Beuda Santa Llogaia d'Alguema Cabanelles Navata Riumors Maià de Montcal Ordis Borrassà Vilamalla Siurana Garrigàs Vilamacolum Crespià Pontós Sant Pere Pescador Torroella de Fluvià Sant Miquel de Fluvià Serinyà Esponellà Santa Eulàlia l'Armentera Bàscara Ventalló Fontcoberta Sant-Mori Vilademuls Vilaür Viladamat Banyoles l'Escala Porqueres Camallera Albons Mata Vilopriu Garrigoles Viladasens Cornellà del Terri Camós Colomers la Tallada d'Empordà Bellcaire d'Empordà Sant Jordi Desvalls Cervià de Ter Verges Palol de Revardit Ullà Bordils Flaçà Foixà Ultramort Torroella de Montgrí Canet d'Adri Sant Julià de Ramis Sant Joan de Mollet Serra de Daró Celrà la Pera Gualta Juià Parlavà Sarrià de Ter Rupià Sant Martí Vell Fontanilles Sant Gregori Madremanya Corçà Ullastret Palau-sator Girona

Fig. 24 – Historical values of Terraprims
From Landscape Observatory of Catalonia

Aquesta informació és de caràcter descriptiu i propositiu no normatiu

Valors històrics
- Castell
- Església i ermita
- Accés arbrat al nucli urbà
- Arbre monumental
- Eix viari històric
- Canal de reg
- Àrea de paisatges agroforestals articulats per masies

Valors històrics lligats a l'aigua
- Salt d'aigua

Valors socials
- Zona de pesca continental
- Equipament d'educació ambiental
- Fira o mercat

Miradors
- 54 Puig Segalar
- 72 Puig Castellar Fontcoberta
- 73 Puig de Valldevià
- 7 Sant Miquel de la Roca

Itineraris
- 1 AP-7
- 3 Eix ferroviari Portbou - Costabrava
- 7 GR-1
- 12 GR210 Ruta del Ter
- 43 Lladó - Mare Deu del Mont
- 57 Sta Creu de Guialbes - Esponellà
- 58 Orriols - Vilopriu - Bàscara
- 59 Medinyà - Jafre
- 119 Vilafreser - Ollers
- 120 Pujals dels Pagesos - Vilavenut - Esponellà
- 121 Bàscara - Ventalló

- Unitat de paisatge
- Edificació existent
- Ferrocarril
- Carretera principal
- Carretera secundària
- Camí
- Riu principal
- Riu secundari

E 1:80.000

0 1.600 3.000 4.800 m

CATÀLEG DE PAISATGE DE LES COMARQUES GIRONINES

Mapa 21.2 Valors històrics simbòlics i socials i miradors i itineraris

Terraprims

Aprovació definitiva
novembre de 2010

Generalitat de Catalunya
Departament de Política Territorial i Obres Públiques

Observatori del Paisatge

Febrer de 2010

CRPPB Barcelona

Universitat de Girona

4.2.1 - Organization and dynamics of the landscape

The name Terraprims means Terra (soil) and Prims (thin), so as the name indicates this unit is compost by thin soil (opposing to terraforts), being characterize by soft relief and soft hills between the river Ter and Fluvià. Floods areas and vegetation associated to this kind of lands.

Fig. 25 -Ter arm meanders between Colomers and San Lorenzo de les Arenes - Terraprims
From Josep Pintó - Landscape Observatory of Catalonia

4.2.2 - Values of the landscape

The values of the landscape who are exalted in this landscape unit are the spaces integrated in the Natura Network 2000, the wet spaces that are catalogued as spaces of great interest in Catalonia, the agroforestry combination with the crops and the woods creating a more balance landscape, the colors in the spring that make a great contrast between the flowering and the green of the forest. Other values of the landscape can be found in the cliffs and historical elements as castles, forts and others strategic constructions that are in the centre of the villages.

Fig. 26 – Vineyard in Parets d'Empordà -Terraprims

From Tânia Azevedo

4.2.3 - SWOT analysis

This SWOT analysis is based in the SWOT made by the Landscape Observatory of Catalonia, available in Catalan in the Landscape Catalogue available in the official website of the Observatory.

Strengths	Weakness
- The non-dispersion of the villages in the hills area allows to a better conservation of the natural, historical and cultural characteristics of the landscape. - A balance agroforestry mosaic, the agricultural area is essential for this balance in the landscape. - High change of working as an ecological and landscape connector between spaces of natural interest. - The rivers Ter and Fluvià gives the identity to the river sides populations. - The architectural heritage in good conditions not only in historical villages but in rural and natural areas.	-Existence of isolated buildings in non-urban land, such as machinery, farms, etc., which are not very well integrated into the territory. -Risk of forest fire accused in the areas of orography more complicated by the abandonment of certain agro-pastoral practices. -The excessive plantations of *Populus* and *Platanus* also affects negatively on the maintenance of the environmental conditions typical of the riversides. -Non-existent indications or denominations that cover local agricultural productions from the perspective of quality and geographical origin. -Part of the historical-architectural heritage does not achieve its optimum regarding the state of conservation.

Opportunities	Threat
-The increasing sensibility of the population regarding the quality of the landscape in their environment can stimulate social initiatives to promote their conservation and to counterbalance hypothetical actions that could endanger it. -The creation of the Fluvià Consortium, currently in process, can have a positive influence on the preservation and improvement of the landscapes of the Fluvià. -The intend of a large urban development in Terraprims hills favors the maintenance of a landscape that preserves its qualities and remains less banal. -The presence of natural, historical and cultural values of the landscape is a favorable starting point for the consolidation of rural tourism.	- The uncertainties in the plan and future of the agrarian activities can make reduce the crop surfaces and modify the structure of the agroforestry mosaics characteristic of the landscape. - The diffused proliferation of farms with little integrated buildings or annexes and the contamination of the phreatic waters that cause the excessive discharge of slurry. - The concentration of urban infrastructures to generate disproportionate urbanistic creations and articulates in relation to historical monuments of small dimensions. - The diffuse and little vertebrate urban growth of some of the municipalities of the Ter valley nearest to the Girona area can lead to a degradation of their own landscape and compromise the ecological and landscape connectivity between the slopes of the Gavarres, the plain alluvial and the river Ter.

Table 8 – SWOT analysis to Terraprims

Based in the SWOT analysis available in the Landscape Catalogue of Comarques Gironines from the Landscape Observatory of Catalonia

4.2.4 - Land uses and evolution

The Landscape Units are in constant change. Land use gives a better perception of these changes and the maps use in this chapter are adaptation of the information available in the CREAF website, that facilitates this information through the years. The maps use is relative to the years of 2005 and 2009, year of the beginning of the mapping of the Landscapes Units and previous year of its approval (the final edition at 30th November 2010 on a resolution from the director general of Architecture and Landscape giving definitive approval for the Landscape Catalogue of the Comarques Gironines). All the data use are official data obtain from the official websites of Catalonia.

In the study of evolution of the land use, the data is referent to 2005 and not to an earlier year because this information wasn't available in vector and having into account the timetable to this work wasn't able to vectorization of previous years.

Map of the Forest Land Uses in 2005 of Terraprims

Legend

- Clear forests (not from riverside)
- Clear riverside forests
- Dense forests (not from riverside)
- Dense riverside forests
- Forests of protection
- Shrubs
- Shrubs - Forests cut everywhere
- Eucalyptus plantations
- Plantations of non-autochthonous conifers
- Plantations of Platanus
- Plantations of Populus
- Meadows and pastures
- Meadows and pastures - forests cut everywhere
- Forest knot floors
- Vegetation of continental wetlands

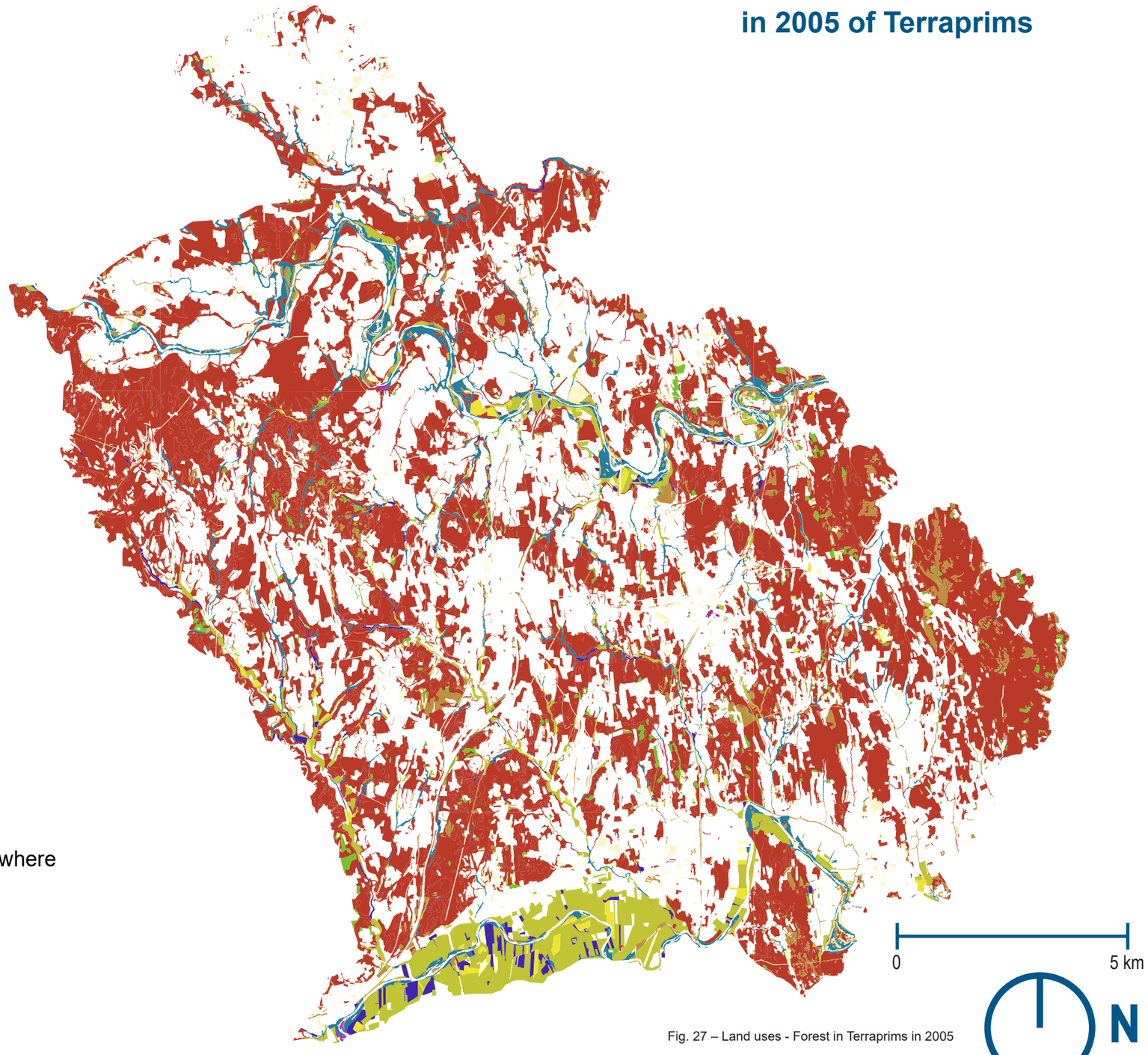


Fig. 27 – Land uses - Forest in Terraprims in 2005

Adapted from CREAF - creaf.uab.es

Map of the Forest Land Uses in 2009 of Terraprims

Legend

- Clear forests (not from riverside)
- Clear riverside forests
- Dense forests (not from riverside)
- Dense riverside forests
- Forests of protection
- Shrubs
- Shrubs - Forests cut everywhere
- Eucalyptus plantations
- Plantations of non-autochthonous conifers
- Plantations of Platanus
- Plantations of Populus
- Meadows and pastures
- Meadows and pastures - forests cut everywhere
- Forest knot floors
- Vegetation of continental wetlands
- Burned areas

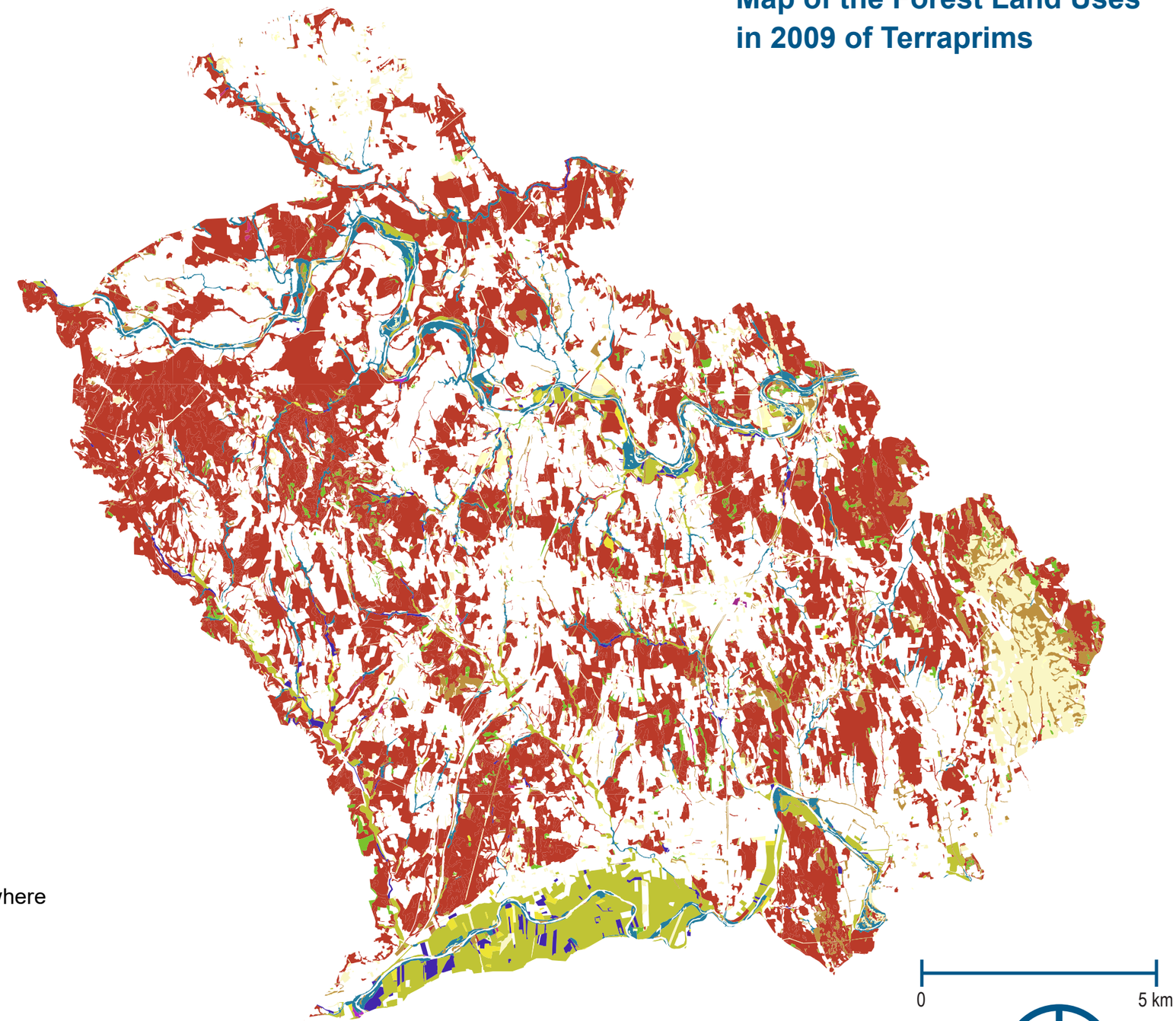


Fig. 28 – Land uses - Forest in Terraprims in 2009

Adapted from CREAF - creaf.uab.es

Map of the Urban Land Uses in 2005 of Terraprims

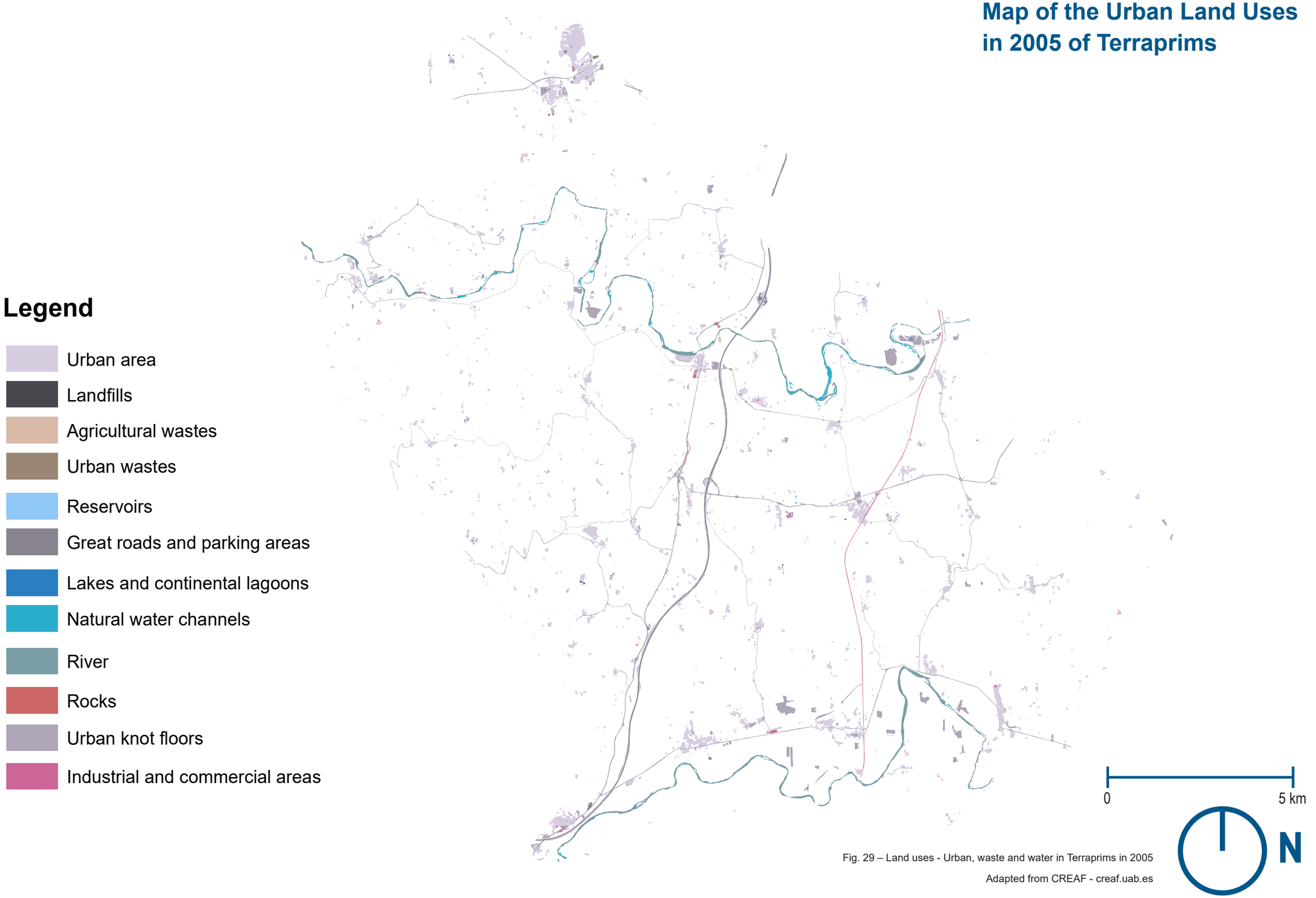


Fig. 29 – Land uses - Urban, waste and water in Terraprims in 2005

Adapted from CREAF - creaf.uab.es

Map of the Urban Land Uses in 2009 of Terraprims

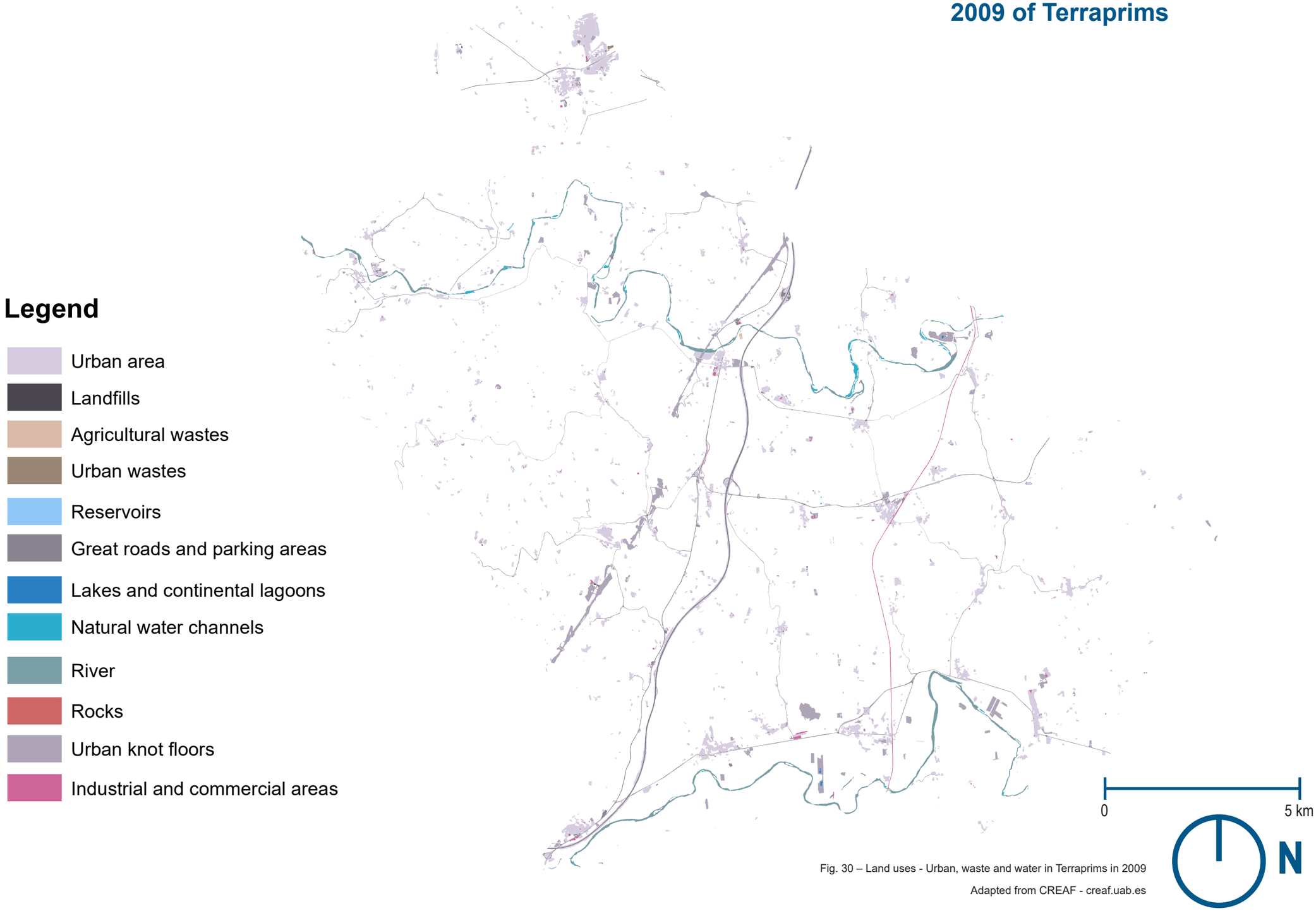


Fig. 30 – Land uses - Urban, waste and water in Terraprims in 2009

Adapted from CREAF - creaf.uab.es

Map of the Agriculture Land Uses in 2005 of Terraprims

Legend

- Abandoned crops - meadows
- Crops in tranformation
- Herbaceous crops (non-arresting)
- Woodland crops (not vineyards)
- Greenhouses
- Vineyards

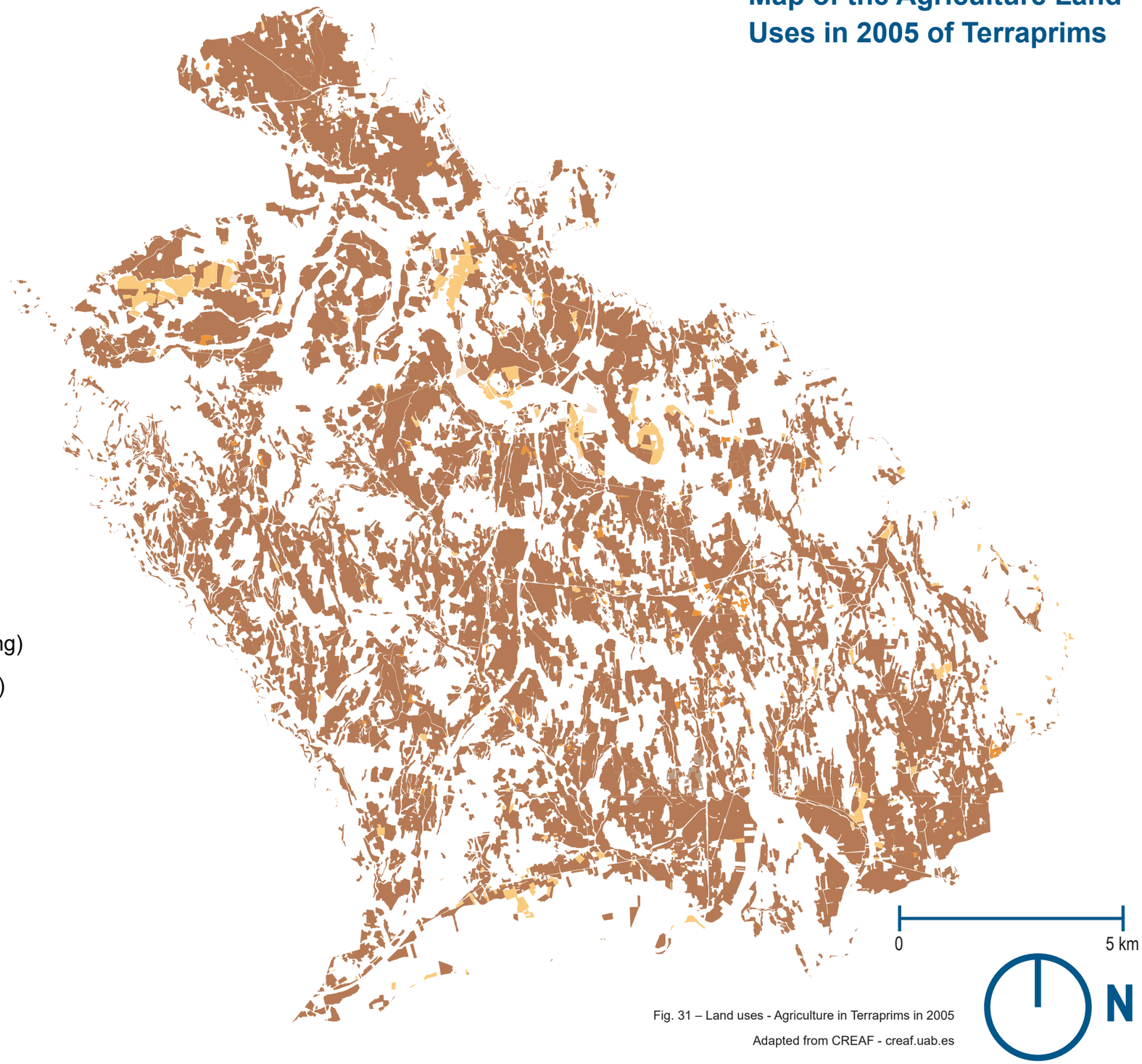


Fig. 31 – Land uses - Agriculture in Terraprims in 2005

Adapted from CREAF - creaf.uab.es

Map of the Agriculture Land Uses in 2009 of Terraprims

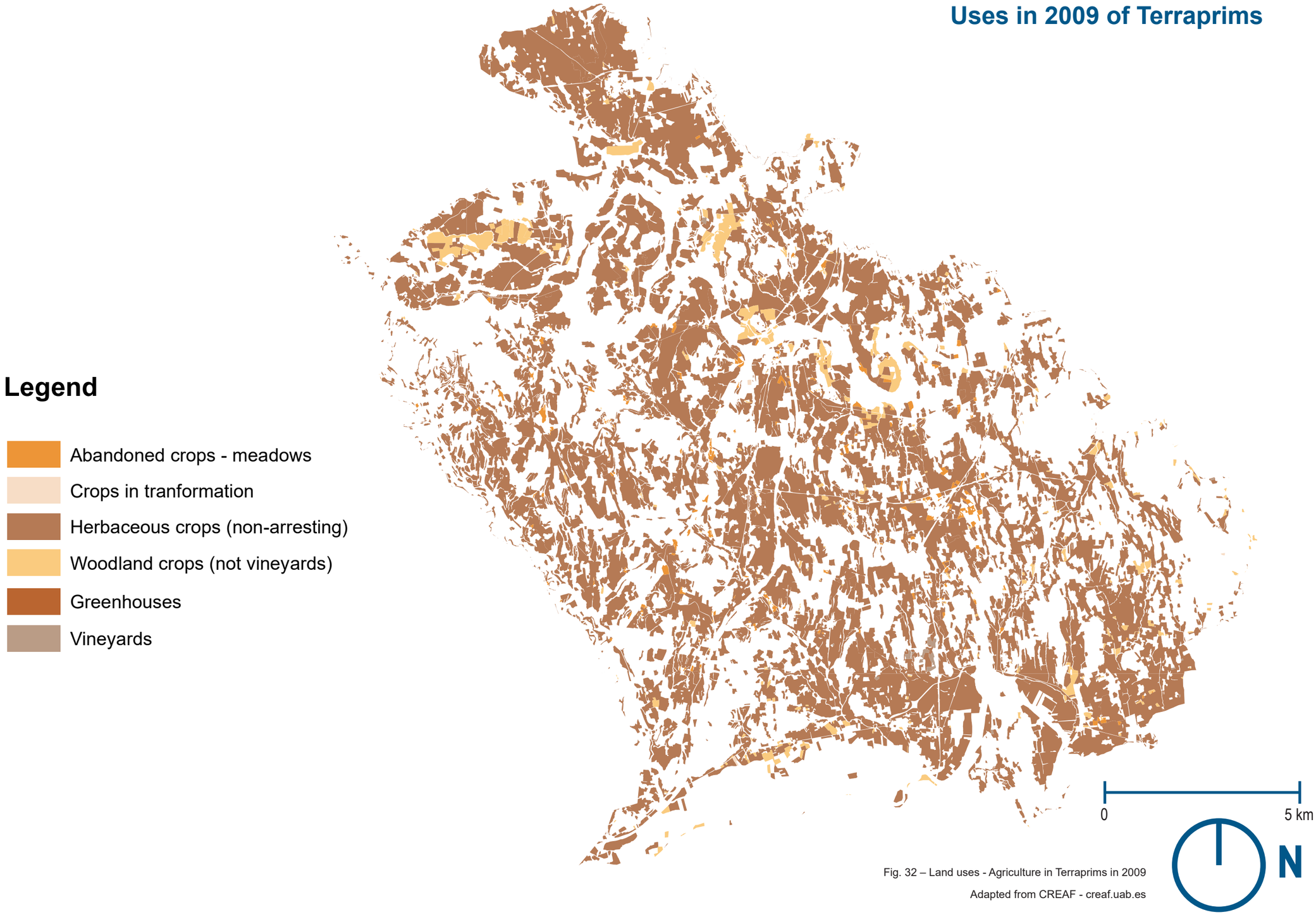


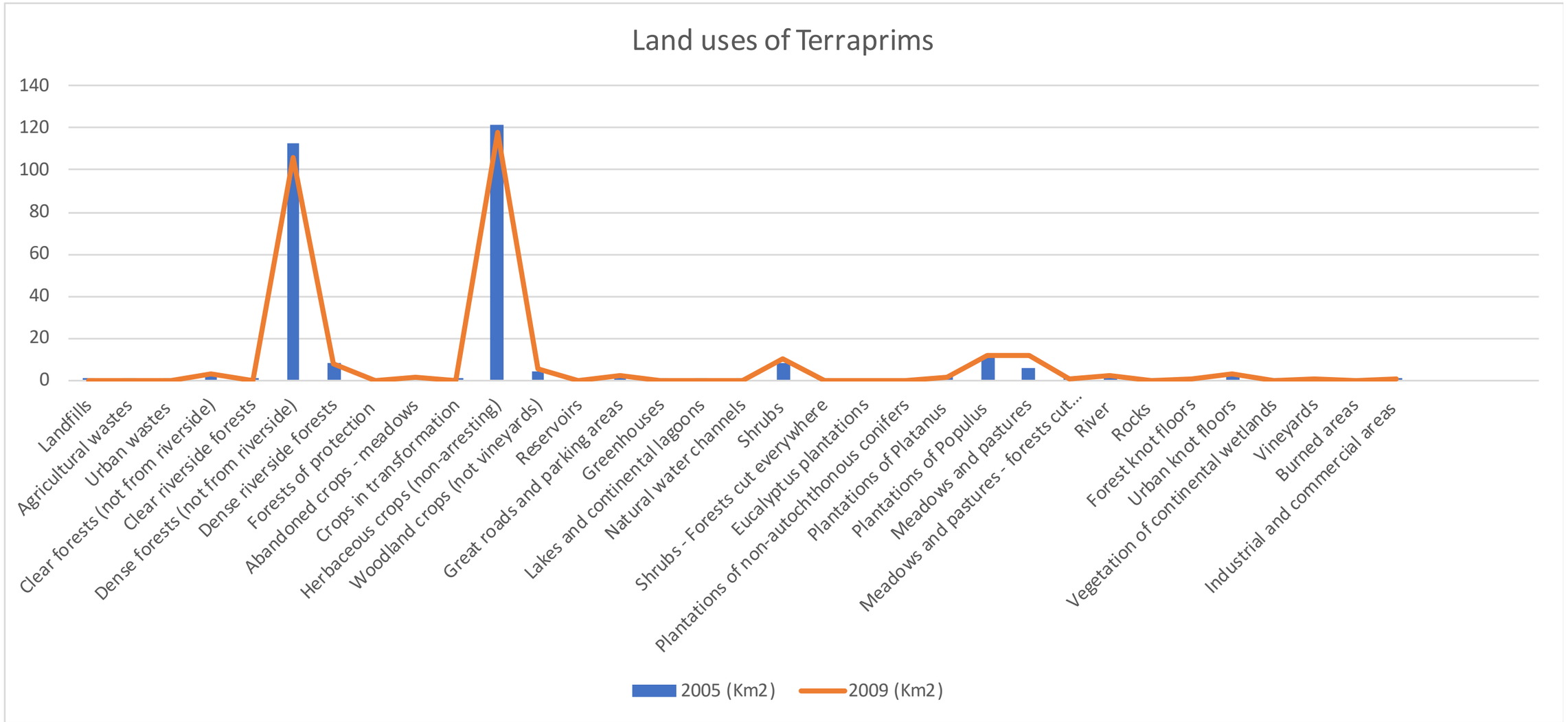
Fig. 32 – Land uses - Agriculture in Terraprims in 2009

Adapted from CREAF - creaf.uab.es

Land uses	2005 (Km^2)	2009 (Km^2)	
Landfills	0,011	0,012	
Agricultural wastes	0,044	0,055	
Urban wastes	0,029	0,031	
Clear forests (not from riverside)	2,44	2,73	↑
Clear riverside forests	0,069	0,046	↓
Dense forests (not from riverside)	112,99	105,86	↓
Dense riverside forests	7,99	8,22	↓
Forests of protection	0	0	
Abandoned crops - meadows	0,93	1,47	↑
Crops in tranformation	0,21	0,054	
Herbaceous crops (non-arresting)	121,15	118,01	
Woodland crops (not vineyards)	4,58	5,50	
Reservoirs	0	0	
Great roads and parking areas	2,27	2,38	
Greenhouses	0,027	0,025	
Lakes and continental lagoons	0,007	0,016	
Natural water channels	0,31	0,19	
Shrubs	8,59	9,84	
Shrubs - Forests cut everywhere	0,054	0,016	
Eucalyptus plantations	0	0	
Plantations of non-autochthonous conifers	0	0	
Plantations of Platanus	1,89	1,74	
Plantations of Populus	11,71	11,93	
Meadows and pastures	6,003	11,45	↑
Meadows and pastures - forests cut everywhere	1,16	0,75	
River	2,07	2,05	
Rocks	0,002	0,002	
Forest knot floors	0,62	1,03	
Urban knot floors	1,58	2,73	↑
Vegetation of continental wetlands	0,021	0,022	
Vineyards	0,25	0,27	
Burned areas	0	0,008	↑
Industrial and commercial areas	0,36	0,39	

Table 9 – Area of each land use in Terraprims in 2005 and 2009

Adapted from CREAF - creaf.uab.es



Graphic 2 – Graphic of the area of each land use in Terraprims in 2005 and 2009

Adapted from CREAF - creaf.uab.es

With the Graphic 2 in columns are presented the area in km^2 of the area per land uses in 2005 and in the line, are presented the area per land use in 2009. The trend is to reduce the area of forest, excepted Clear forest (not from riverside), Dense riverside forest and Shrubs that didn't show a considerable growth. The land use that present a major reduction of area is Shrubs – Forest cut everywhere. The land uses that show a bigger grow are the abandoned crops – meadows, a tendency from previous years that are present in the landscape catalogues as a threat to the character of the landscape, other growth in area are the Meadows and pastures, that corroborates with the previous statement. The burned areas that in 2005 don't exist in the Terraprims landscape.

The reduction of Forest area as a tendency and the fast growth of the abandoned crops have a major impact in the Landscape character and allied with a growth of the urban area contributes to an increase of CO_2 emissions.

4.3 - Landscape quality objectives

The Landscape Quality Objectives present in this chapter are the Landscape Quality Objectives elaborated by the Landscape Observatory of Catalonia and integrated in the Landscape Catalogue – Comarques Gironines available in the chapter referring to the Landscape Unit of Terraprims and Plana de la Selva respectively.

The Landscape Quality Objectives are a proposal of measures and actions, made by the Landscape Observatory of Catalonia, specifically for each Landscape Unit. This proposal has into account the vision of the Landscape Observatory of Catalonia and the Catalonia Government, to the future of the land of Catalonia. Due the importance of these Objectives, they are made into account of all the proposals of this study.

4.3.1 – Plana de la Selva

LQO1 – The trace elements of volcanic activity as the La Crosa de Sant Dalmi building, preserved and explored as a teaching and tourist resources.

LQO2 - Wetlands and swaps managed and improve the ecological diversity.

LQO3 – landscape and vegetation associated to river sides preserved and value as connectors and systems of territorial structure.

LQO4 - Villages as Santa Coloma de Farners, Maçanet de la Selva, Vidreres, Llagostera, Riudarenes, Sils, Caldes de Malavella, Cassà de la Selva and Vilobí d' Onyar, integrated in

the landscape valuing the surroundings.

LQO5 - Some of the linear infrastructures well integrated in the landscape improve the connection between the different parts of the territory without compromise the continuity both social and ecological.

LQO6 - Photovoltaic parks, well planned and embedded in the landscape in relation to their configuration elements.

LQO7 - A system of farmhouses and historic roads well preserved and enhanced as articulating elements of the mosaic of Plana de la Selva.

LQO8 - A system of itineraries and viewpoints that emphasize the most relevant panoramic views and allow you to discover and interact with the diversity and nuances of the landscapes of the Plana de la Selva.

4.3.2 – Terraprims

LQO1 - The nuclei that make up the landlord of Terraprims (Crespià, Esponellà, Vilademuls, Vilaür, Galliners, Vilafreser, Camallera, Gaüses, Llampaies, Vilavenut, Sant Marçal de Quarantella, Sant Esteve de Guialbes, Orfes, Espinavessa, Vilademí, neighbourhood of 'In Deri, Perles, Viella, Arenys d'Empordà, Vilamarí, Parets d'Empordà and Les Olives), preserved and revalued, maintained as a visual reference and quality identity.

LQO2 - A system of linear infrastructures constituted by the AP-7, the N-II, the rail axis of Portbou-Hostalric and the TAV that does not generate fractures in the territory and where its implantation corresponds to criteria of landscape integration.

LQO3 - Specialized areas for industrial, logistical, commercial and tertiary uses, located in non-preferred visual areas and designed considering the integration in the environment.

LQO4 - A forest landscape composed mainly of Quercus ilex and Pinus sp., as well as Quercus robur, preserved in its limits and maintained in its relation with the areas of cultivation.

LQO5 - A preserved and well managed agroforestry landscape that maintains the diversity of elements that characterize it and give it its own identity.

LQO6 - Fluvià and Ter river fluvial landscapes well preserved and revalued as landscape identifiers and reinforced in their role as a landscape connector, recreation and social enjoyment space.

LQO7 - A system of channels of Sant Jordi al Ter (Medinyà, Cervià de Ter, Sant Jordi Desvalls, etc.) and of the Fluvià (Bàscara), as well as of hydraulic infrastructures, recovered,

rehabilitated and valued based on their consideration as structural element of the surroundings of the Terraprims river courses.

LQO8 - A system of itineraries and viewpoints that emphasize the most relevant panoramic views and allow you to discover and interact with the diversity and nuances of the landscapes of Terraprims.

Chapter 5 – Proposal

The proposal will reflect about the capacity of the land uses to emit and capture CO_2. This capacity will influenciate the Landscape Quality Objectives and the measures to reduce emissions and to increase the capture of CO_2.

The information of population, industry, land uses and additional information was obtained on the official websites of the Government of Catalonia, Generalitat de Catalunya.

5.1 - Emissions of CO_2 and Land uses

The figures 33 and 34 represent the main land uses and the production of CO_2 emissions by municipality. These maps is divide in 5 or 6 categories of land uses (Urban areas; Continental waters; Artificial unproductive; Forests land; Crops;and in the Terraprims, Burned areas) and in 5 categories of Tons of CO_2 emissions (1 000, 5 000, 10 000, 50 000 and 100 000).

The figure 33 correspond to the land uses of Plana de la Selva and it is visible that the areas with crops, urban areas and artificial unproductive have a bigger CO_2 emissions, and the municipals mainly covered by forest have less CO_2 emissions. The areas that correspond with forests land, all together have a capacity of capture 1.206.972,1 Tons of CO_2 (see table 9, in Chapter 4).

Map of sectors with emissions of CO_2 by municipal in Plana de la Selva

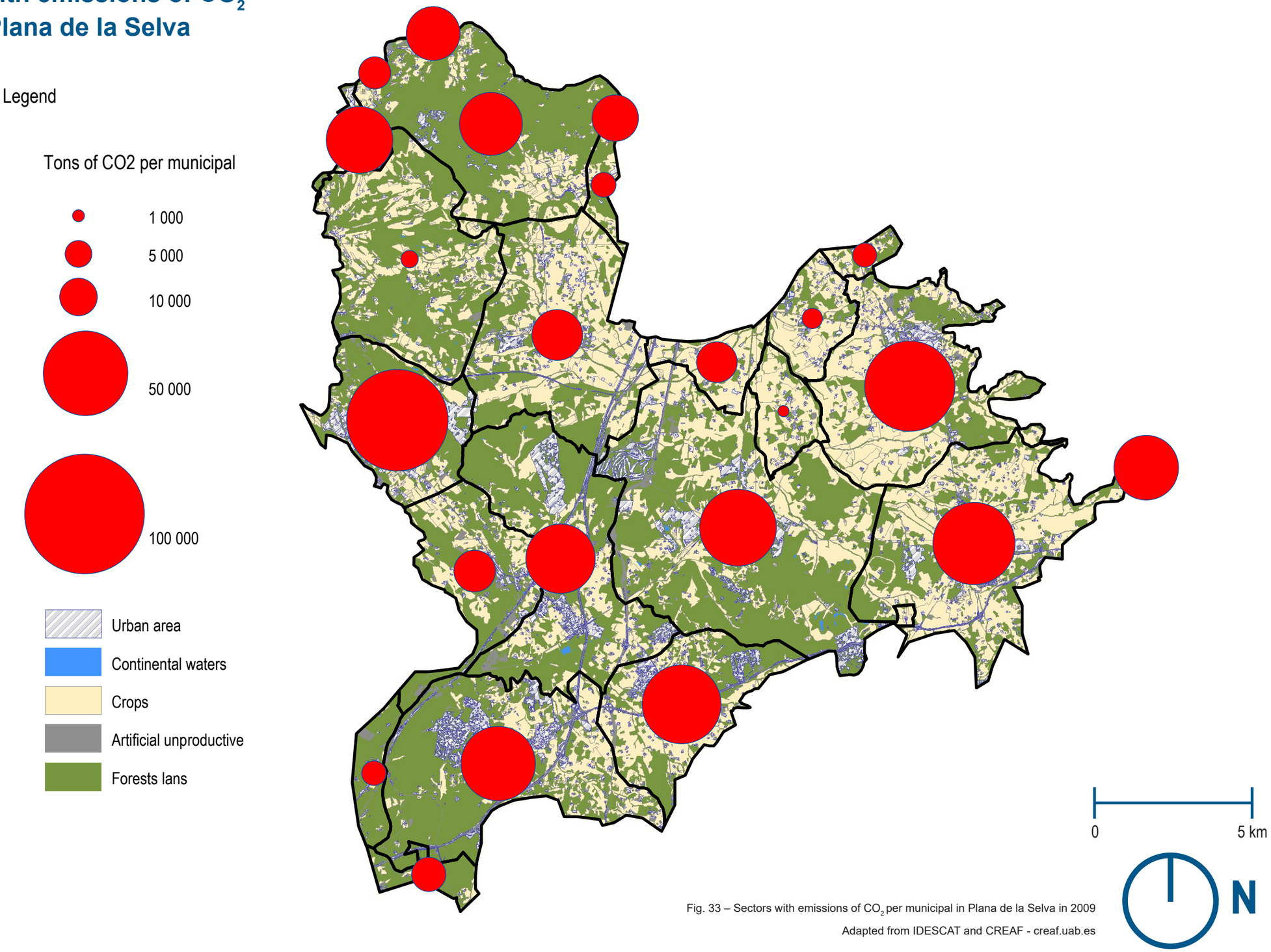


Fig. 33 – Sectors with emissions of CO_2 per municipal in Plana de la Selva in 2009

Adapted from IDESCAT and CREAF - creaf.uab.es

In the figure 33 is visible that the municipals with more emission of CO_2 are the ones with more Urban areas and Artificial unproductive and in the case of the seven municipality on the east side the major land use is Crops (Agriculture). This land use have the biggest rate of emissions, in this unit, as is possible to see in the table 10, being the second land use with the biggest area (the first is forest).

The Table 10 represents the emissions in tons of CO_2 in Catalonia per year, for each of the five-main land use or sectors (Urban, Agriculture, Industry, Waste, Continental water and Forest). Each of this emissions factor were multiplied for the area of each sector and divided for the total area of each sector in Catalonia. For the emission factor isn't consider the emissions of plantation and pollution, because the emissions factor of the Forest and water is zero. All the values used including the emissions factor in Catalonia are obtain from the CREAF or from the IDESCAT.

Sectors	Emissions factor t CO_2/ year in Catalonia	Area (km^2)	t CO_2/year
Urban	2295	9,77	11,28
Agriculture	5478	136,58	80,00
Industry	14584	1,76	38,83
Water	0	0,59	0
Forest	0	173,57	0
Waste	2910	0,63	18,41
		Total	148,52

Table 10 – Sectors with emissions of tons of CO_2 per year in Plana de la Selva
Adapted from IDESCAT and CREAF - creaf.uab.es

The figure 34 correspond to the land uses of Terraprims and it is visible that the areas with crops, urban areas, artificial unproductive and burned areas have a bigger CO_2 emissions, and the municipals mainly covered by forest have less CO_2 emissions. The areas that correspond with forests land, all together have a capacity of capture 972.099,9 Tons of CO_2 (see table 10, in Chapter 4).

Map of sectors with emissions of CO_2 by municipal in Terraprims

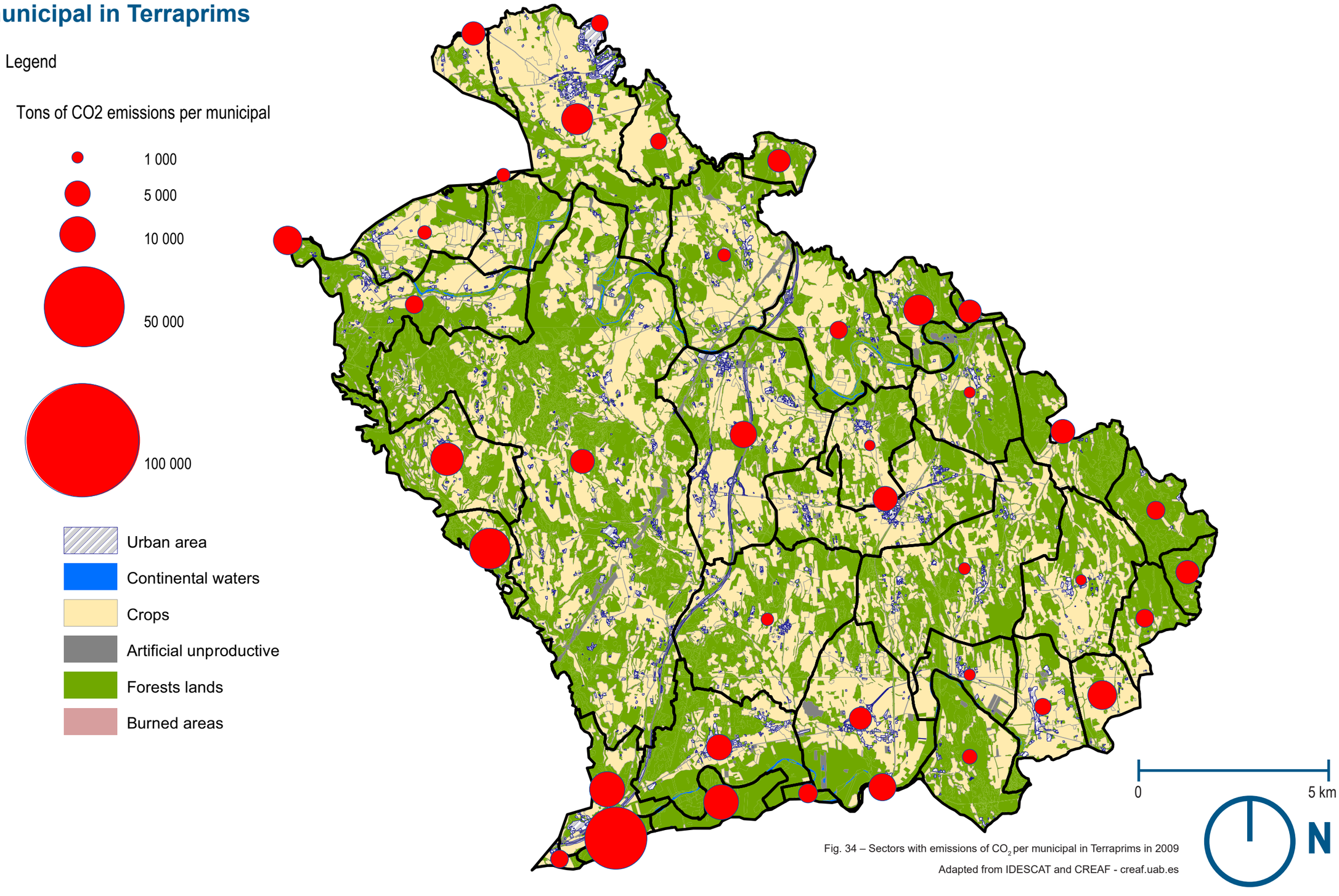


Fig. 34 – Sectors with emissions of CO_2 per municipal in Terraprims in 2009

Adapted from IDESCAT and CREAF - creaf.uab.es

In the figure 34, the emissions per municipal are considerable lower that in Plana de la Selva, being the Crops (Agriculture) the biggest contributor, as is visible in the table 11. The character rural of the urban areas contributes to a reduction of the emissions, the scarcity of industrial areas and the roads that connect this unit whit the adjacent ones allow this unit to continue being a unit of rural character where the forest have the biggest area.

The Table 11 represents the emissions in tons of CO_2 in Catalonia per year, for each of the five-main land use or sectors (Urban, Agriculture, Industry, Waste, Continental water and Forest). As reffered, each of this emissions factor were multiplied for the area of each sector and divide for the total area of each sector in Catalonia. For the emission factor isn't consider the emissions of plantation and pollution, because of this the emissions factor of the Forest and water is zero. All the values use are obtain from the CREAF or from the IDESCAT.

Sectors	Emissions factor t CO_2/ year in Catalonia	Area (km^2)	t CO_2/year
Urban	2295	5,13	5,92
Agriculture	5478	125,33	73,41
Industry	14584	0,39	8,58
Water	0	2,267	0
Forest	0	152,75	0
Waste	2910	0,086	2,50
		Total	90.41

Table 11 – Sectors with emissions of tons of CO_2 per year in Terraprims
Adapted from IDESCAT and CREAF - creaf.uab.es

The figures 35 and 36 represents the area and the land uses that contribute to the capture of CO_2. The rate of capture was calculated according to the rate of capture per individual per specie available in annex of the report Ecological Services of Urban Forest in Barcelona (Chaparro & Terradas, 2009). With this values and the data of the total area of the each land use, obtain in the CREAF website, was possible the calculation of the ratio of capture of CO_2 for each land use existing in the Landscape Units.

The results are obtained though the division of the area of each land use per the ratio of occupation of the prevailing specie (value estimate differ with the density and specie). After the estimative of the number of existing individual per specie this number was multiply by the value of the capture of CO_2 per individual per specie. The final result are available in the table 12 and 13.

The values of CO_2 capture was only calculated for the land uses that have a value of capture bigger than emissions, not taking into account the capacity of absorption of CO_2 of the soil, due to the time table for this study and the number of variables, as geologicals.

In the Fig. 35 and 36 are represented the area of land uses with the ability to capture CO_2 in bigger proportions than emitting. The land uses with the ratio of emissions superior to the ratio of capture will be considered their ability to capture CO_2 equal zero, to an easier evaluation without having into account the all the factors involve to the capture and emission of carbon due to the available amount of time. For the same reason all the land uses with an ability to capture CO_2 will be considered their ability to emit CO_2 equal to zero.

To calculate the capture in each land use were use the predominant specie and the others weren't considered for lack of information.

Map of area of Land uses and capture of CO_2 in Plana de la Selva in 2009

Legend

- Clear forests (not from riverside)
- Clear riverside forests
- Dense forest (not from riverside)
- Dense riverside forest
- Forest of protection
- Shrubs
- Shrubs - Forest cut everywhere
- Eucalyptus plantation
- Plantation of non-autochthonuous conifers
- Plantation of *Platanus*
- Plantation of *Populus*
- Vegetation of continental wetlands

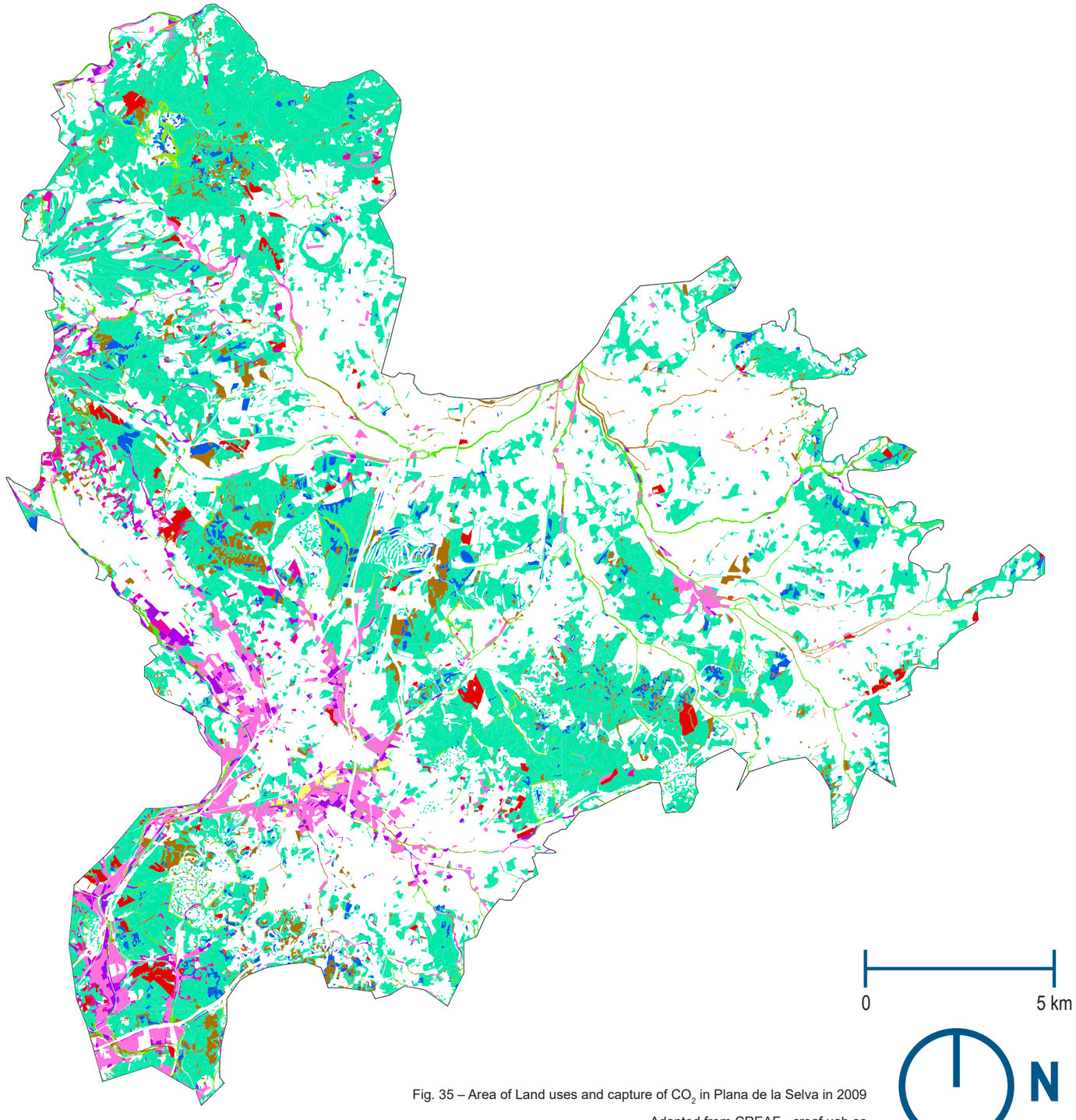


Fig. 35 – Area of Land uses and capture of CO_2 in Plana de la Selva in 2009

Adapted from CREAF - creaf.uab.es

Legend	Total area (km^2)	t CO_2 / year
Clear forests (not from riverside)	6,37	371,9
Clear riverside forests	0,13	363,2
Dense forests (not from riverside)	114,02	17.746,7
Dense riverside forests	0,45	968,6
Forests of protection	1,01	117,7
Shrubs	11,59	2.250,8
Shrubs - Forests cut everywhere	0,29	22,8
Eucalyptus plantations	3,87	4.353,9
Plantations of non-autochthonous conifers	2,60	812,96
Plantations of Platanus	0,42	1.827,3
Plantations of Populus	11,96	11.353,5
Vegetation of continental wetlands	0,29	42,9
	Total	40.232,26

Table 12 – Area of each land use and ratio of CO_2 capture per year in Plana de la Selva in 2009

Adapted from CREAF - creaf.uab.es

In the figure 35 are presented twelve land uses, as the uses that capture CO_2, followed by the table 12 where is presented the area occupied for each land use and respective quantity of CO_2 capture in tons of CO_2 per year. In the case of Plana de la Selva the land uses with major capture of CO_2 per year are the Dense forest (not from riverside) with 17.746,7 tCO_2/ year followed by Plantation of *Populus* with 11.353,5 tCO_2/year, the predominant specie is *Pinus* sp. and *Populus* sp. respectively. The land uses with major capture values are the same with major cover area. In the total the capture per landscape unit per year is 40.232,4 tCO_2/year.

With this map (Fig. 35) and table 12 is possible to conclude that area of occupation of a land use is important but the specie planted is also very important. Shrubs that have a similar area that Plantations of *Populus* (11.59 km^2 and 11.96 km^2, respectively) have the capacity to capture CO_2. This value is significantly less (2.250,8 tCO_2/year and 11.353,5 tCO_2/year, respectively), and the difference occurs because of the capacity of each specie to capture carbon and the density of plantation of each specie.

Map of area of Land uses and capture of CO_2 Terraprims in 2009

Legend

- Clear forests (not from riverside)
- Clear riverside forests
- Dense forest (not from riverside)
- Dense riverside forest
- Shrubs
- Shrubs - Forest cut everywhere
- Plantation of *Platanus*
- Plantation of *Populus*
- Vegetation of continental wetlands

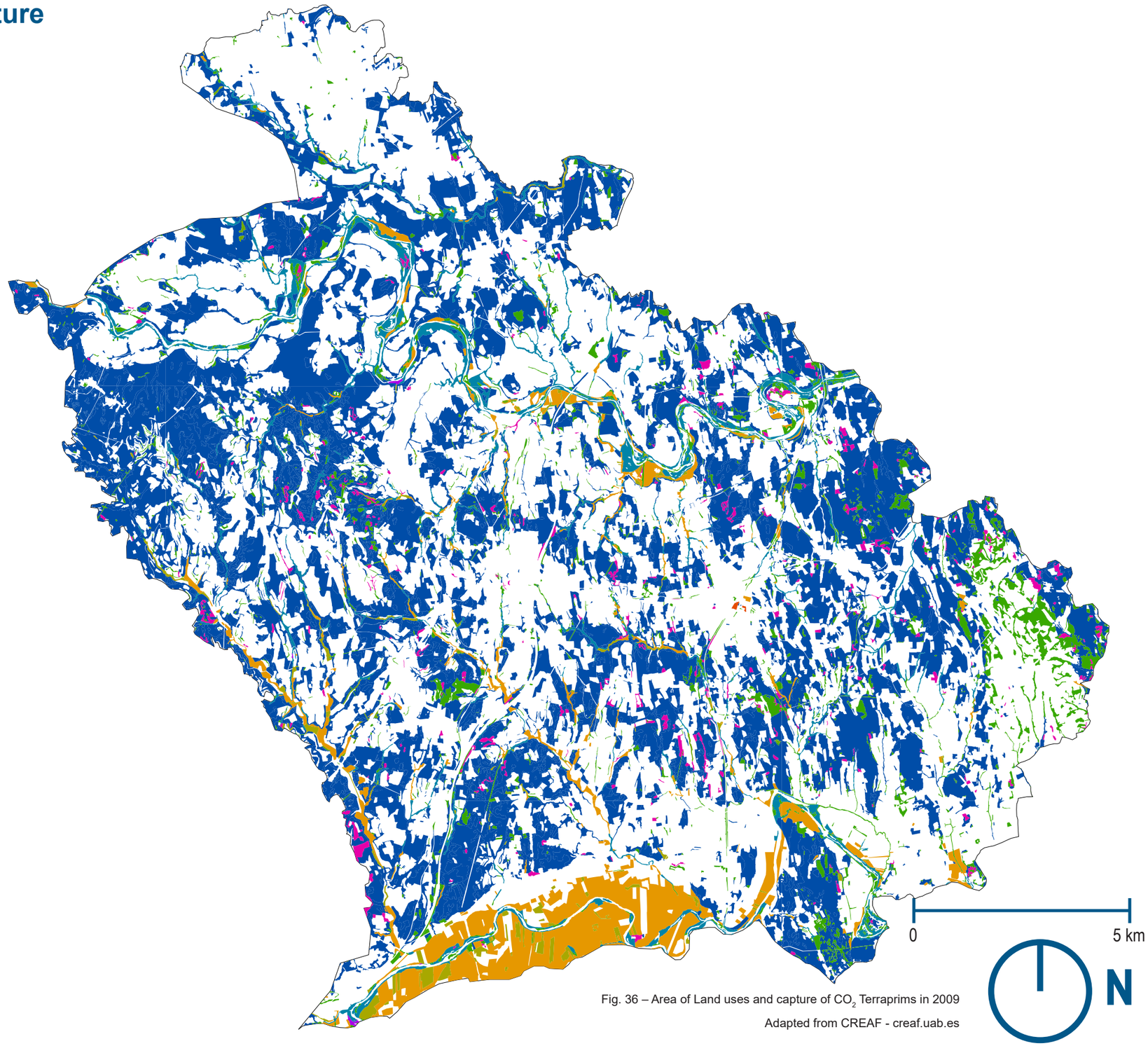


Fig. 36 – Area of Land uses and capture of CO_2 Terraprims in 2009

Adapted from CREAF - creaf.uab.es

Legend	Total area (km^2)	t CO_2 / year
Clear forests (not from riverside)	2,73	159,24
Clear riverside forests	0,05	3,72
Dense forests (not from riverside)	105,86	16.476,05
Dense riverside forests	8,22	1.757,15
Shrubs	9,84	1.911,05
Shrubs - Forests cut everywhere	0,16	12,77
Plantations of *Platanus*	1,74	760,83
Plantations of *Populus*	11,9	11.319,29
Vegetation of continental wetlands	0,02	3,22
	Total	32.402,32

Table 13 – Area of each land use and ratio of CO_2 capture per year in Terraprims in 2009

Adapted from CREAF - creaf.uab.es

In the figure 36 are presented nine land uses, this uses have the capacity to capture CO_2. In the table 13 is possible to see the area occupied for each land use and respective quantity of CO_2 capture in tons of CO_2 per year. In the case of Terraprims the land uses with major capture of CO_2 per year are the Dense forest (not from riverside) with 16.476,1 tCO_2/year followed by Plantation of *Populus* with 11.319,3 tCO_2/year, the predominant specie in these land uses are *Pinus* sp. and *Populus* sp. respectively, the land uses with major capture values are the same with major cover area. In the total the capture per landscape unit per year is 32.403,3 tCO_2/year.

The map (Fig. 36) and table 13 show the area of occupation of a land use and permit the conclusion of the importance of the specie planted. Clear forest (not from riverside) that have more area than the Plantations of *Platanus* (2,73 km^2 and 1.73 km^2, respectively) have the capacity to capture CO_2 significantly less (159,24 tCO_2/year and 760.83 tCO_2/ year, respectively). This difference occurs because of the capacity of each specie to capture carbon and the density of plantation of each specie.

5.2 – Applications of the guidelines in the land uses

The tables 14 and 15 are an adaptation of the measures present in the table 3 of the Chapter 2, having into account the specificities of the landscape. This study proposed an adjustment to Landscape Quality Objectives to achieve a major CO_2 emissions reduction.

In the table 14 and table 15 are propose the alteration of four Landscape Quality Objectives with the intent to reduce emissions. The measures proposed in the last column represent an adaptation of the Table 3, Chapter 2, to the reality of the landscape aboard in the Landscape Quality Objectives that have into account the reality of the unit and their potentialities. These measures are related with the different land uses study previously.

Plana de la Selva	Landscape Quality Objectives Existent	Landscape Quality Objectives Propose	Measures
	LQO1 - The trace elements of volcanic activity as the La Crosa de Sant Dalmi building, preserved and explored as a teaching and touristic resources.		Green connectors between the volcano elements, improving the habits to the autochthonous species
	LQO2 - Wetlands and swaps managed and improve the ecological diversity		Implementation of more elements associated to the wetlands that will improve the quality of habitats
	LQO3 - landscape and vegetation associated to river sides preserved and value as connecters and systems of territorial structure.		Increase of the area with natural vegetation associated to riversides

Plana de la Selva	Landscape Quality Objectives Existent	Landscape Quality Objectives Propose	Measures
	LQO4 - Villages as Santa Coloma de Farners, Maçanet de la Selva, Vidreres, Llagostera, Riudarenes, Sils, Caldes de Malavella, Cassà de la Selva and Vilobí d' Onyar, integrated in the landscape valuing the surroundings.	Integrate the urban areas with the surroundings	Create green connectors between villages
	LQO5 - Some of the linear infrastructures well integrated in the landscape improve the connection between the different parts of the territory without compromise the continuity both social and ecological.	Integration of the linear infrastructures in the landscape	Plantation of vegetation close to the roads (tree lines etc.) Reduce the visual impact using vegetation
	LQO6 - Photovoltaic parks, well planned and embedded in the landscape in relation to their configuration elements.	Infrastructures of renewable energies well implemented in the landscape	Use of the renewable energies in all unit Implementation of infrastructures of renewable energies in places with low impact Use vegetation to reduce impacte

Plana de la Selva	Landscape Quality Objectives Existent	Landscape Quality Objectives Propose	Measures
	LQO7- A system of farmhouses and historic roads well preserved and enhanced as articulating elements of the mosaic of Plana de la Selva.		Farmhouse well implemented in the landscape Reduce of the use of heavy machinery
	LQO8 - A system of itineraries and viewpoints that emphasize the most relevant panoramic views and allow you to discover and interact with the diversity and nuances of the landscapes of the Plana de la Selva.	Places of contemplation with a rich ecological value that enables learning of the characteristics of the landscape	Viewpoints surrounded by characteristic landscape Use of autochthonous species Create conditions to the implementation of natural habitats

Table 14 – Measures to reduce CO_2 emissions per Land Use

Adapted from the table 2, Chapter 2

Terraprims	Landscape Quality Objectives Existent	Landscape Quality Objectives Proposed	Measures
	LQO1 - The nuclei that make up the landlord of Terraprims (Crespià, Esponellà, Vilademuls, Vilaür, Galliners, Vilafreser, Camallera, Gaüses, Llampaies, Vilavenut, Sant Marçal de Quarantella, Sant Esteve de Guialbes, Orfes, Espinavessa, Vilademí, neighborhood of 'In Deri, Perles, Viella, Arenys d'Empordà, Vilamarí, Parets d'Empordà and Les Olives), preserved and revalued, maintained as a visual reference and quality identity.	Preserve the rural characteristics of the landscape	Preserve the characteristic landscape Use of autochthonous vegetation
	LQO2 - A system of linear infrastructures constituted by the AP-7, the N-II, the rail axis of Portbou-Hostalric and the TAV that does not generate fractures in the territory and where its implantation corresponds to criteria of landscape integration.	Integration of the linear infrastructures in the landscape	Create green connectors between villages Plantation of vegetation close to the roads (tree lines etc.)
	LQO3 - Specialized areas for industrial, logistical, commercial and tertiary uses, located in non-preferred visual areas and designed considering the integration in the environment.		Balance the areas of industry with areas of vegetation Use of renewable energy sources Improvement of the transportation and local trade

Terraprims	Landscape Quality Objectives Existent	Landscape Quality Objectives Proposed	Measures
	LQO4 - A forest landscape composed mainly of *Quercus ilex* and *Pinus* sp., as well as Quercus robur, preserved in its limits and maintained in its relation with the areas of cultivation.		Create conditions to the development of the species (Quercus ilex, Pinus spp. And Quercus robur)
	LQO5 - A preserved and well managed agroforestry landscape that maintains the diversity of elements that characterize it and give it its own identity.		Increase the area of forest without compromise the landscape character
	LQO6 - Fluvià and Ter river fluvial landscapes well preserved and revalued as landscape identifiers and reinforced in their role as a landscape connector, recreation and social enjoyment space.		Increase of the area with natural vegetation associated to riversides
	LQO7 - A system of channels of Sant Jordi al Ter (Medinyà, Cervià de Ter, Sant Jordi Desvalls, etc.) and of the Fluvià (Bàscara), as well as of hydraulic infrastructures, recovered, rehabilitated and valued based on their consideration as structural element of the surroundings of the Terraprims river courses.		Depollute the water Use water lines to irrigation of the crops Plantation of riparian gallery

Terraprims	Landscape Quality Objectives Existent	Landscape Quality Objectives Proposed	Measures
	LQO8 - A system of itineraries and viewpoints that emphasize the most relevant panoramic views and allow you to discover and interact with the diversity and nuances of the landscapes of Terraprims.		Viewpoints surrounded by characteristic landscape Use of autochthonous species Create conditions to the implementation of natural habitats

Table 15 – Measures to reduce CO_2 emissions per Land Use

Adapted from the table 2, Chapter 2

5.3 – Potential reduction of CO_2 per Land Use

The values present in the tables 16 and 17 show a estimative of the potentialities of reductions with the measures when applied to the landscape units.

In Plana de la Selva which have 322,9 km^2 of area, the total of tons of CO_2 emissions in one year is 148,5 tCO_2/year. After implemented the action to reduce the carbon emissions present in the table 14 (Chapter 5), with the factor of reduction present in the table 2 (Chapter 2), the emissions can be reduce to 105,7 tCO_2/year in a total of reduction of 42,8 tCO_2/year (28,84%).

Sectors	Emissions factor t CO_2/year in Catalonia	t CO_2/year	% of reduction	Reduction of tons of CO_2 emissions to	
Urban	2.295	11,28	30%		7,89
Agriculture	5.478	80	23%		61,60
Industry	14.584	38,82	40%		23,29
Water	0	0	5%		0
Forest	0	0	10%		0
Waste	2.910	18,41	30%		12,88
				Total	105,66

Table 16 – Tons of CO_2 emit after the application of the actions to reduce emission in Plana de la Selva

Adapted from the table 2, Chapter 2

In the case of Terraprims the results are similar to Plana de la Selva, in an area of 285,96 km^2 are emit 90,4 tCO_2/year in total of every sector. After the implementation of the action to reduce emissions of CO_2, the landscape unit will reduce the emissions to 67,6 tCO_2/year, reducing 22,8 tCO_2/year (25,26%). Some of this actions/measures only can be implemented one time, so the percentage of reduction in the first year is higher than the following years.

Sectors	Emissions factor t CO_2/year in Catalonia	t CO_2/year	% of reduction	Reduction of tons of CO_2 emissions to	
Urban	2.295	5,92	30%		4,14
Agriculture	5.478	73,41	23%		56,52
Industry	14.584	8,57	40%		5,14
Water	0	0	5%		0
Forest	0	0	10%		0
Waste	2.910	2,50	30%		1,75
				Total	67,55

Table 17 – Tons of CO_2 emit after the application of the actions to reduce emission in Terraprims

Adapted from the table 2, Chapter 2

The main difficulties present in this report are the calculation of the CO_2 emissions for the different land uses and collecting the information about the different activities and land covers in the different years. The landscape and land uses in Catalonia don't suffer meaningful alterations since 2009 due to the financial crisis of Spain. The base of the maps use in this research are relative to the lands uses of 2009, which is the most recent information of Catalonia available in the official websites, when cross-check this data with google satellite's images the biggest change is in the increase of abandoned land but in a not considerable ratio.

When compared the ratio of emissions with the capture ratio (Plana de la Selva: emissions 148.5 tCO_2/year, capture 40232.4 tCO_2/year; Terraprims: emissions 90.4 tCO_2/year, capture 32403.3 tCO_2/year) is easy to understand that landscape units have the ability of being a carbon sink in Catalonia. Nevertheless the measures propose in this study contribute to a reduction in 28.84% (Plana de la Selva) and 23.26% (Terraprims) of CO_2 emissions.

This research shows that even in the areas where the capture of CO_2 is higher that the emission it's possible to reduce the CO_2 emissions and contribute to achieve the objectives of the Paris Agreement.

Conclusion and Recommendations

This report is the result of an internship developed at Landscape Observatory of Catalonia, under the theme “Landscape for a Low-Carbon Future: Guidelines for a CO_2 reduction through land uses changes in Catalonia”. The aim of this was to propose guidelines to reduce carbon emissions through land uses changes without changing landscape character, using the landscape unit as the intervention area, through the definition of Landscape Quality Objectives and measures to achieve it. To achieve these goal four research questions were established, a literature review was made and two case studies were selected: Landscape Units of Plana de la Selva and Terraprims.

The literature review focused on the concept of “Low Carbon Society”, how to calculate carbon emissions and capture and what kind of measures can be applied to the different land uses in order to increase the capture of CO_2. It was possible to conclude that these measures are especially related to the increasing of vegetation areas, spaces management, waste reducing, renewable energy sources use, improvement of the technologies and hydraulic resources preservation.

A short characterisation of Catalan landscapes laws was made and explained how the Landscape Observatory was set. All the research developed since its creation and the production of the landscape catalogues were a crucial information to choose the case studies and to have information regarding their characterization, diagnose and to understand its character. Through the study of these two landscapes and the evaluation of all their features and values, it was possible to culminate with the SWOT analyses, where were identified the most characterising features and the biggest threats to those landscapes as is known. These helped in the identification of the landscape and land uses that should be change during the proposal. The SWOT was also fundamental to propose new LQO and measures to reduce CO_2 emissions.

Reflecting on which are the main sources of carbon in the two landscape units studied, we concluded that the main sources of the carbon study in the Landscape Units – Plana de la Selva and Terraprims - are the agriculture and urban areas. Regarding the capacity of capture carbon, forest areas are the bigger contributor in the landscape units. We also concluded that the capacity to capture CO_2 is bigger than the capacity to emit CO_2. As refereed, this study reflects about land uses and the capture and emissions of CO_2, aiming to propose new LQO and measures to reduce carbon emissions. After the calculation of emissions and capture, we concluded that in the two Landscape Units studied the capacity to CO_2 capture is higher than the capacity to emit. In summation, both of this Landscape Units work as a

carbon sink in Catalonia and although the differences between them, is also possible to conclude that the land use and species used are very important for the CO_2 capture.

The capacity of CO_2 capture by the vegetation was calculated and in the both Landscape Units. The land use that capture more CO_2 was the Dense forest (not from riverside) with 17.746,7 tCO_2/year in Plana de la Selva and 16.476,05 tCO_2/year in Terraprims, but the capacity of the land use of Plantation of *Populus* have similar capture per year in a minor area in both Landscape Units. The land uses that present less capacity to capture CO_2 are Shrubs -Forest cut everywhere, in the case of the Plana de la Selva and Vegetation of continental wetlands, in case of Terraprims, being the land uses that presented the smallest areas.

Another research question proposed was to understand if nowadays Plana de la Selva and Terraprims LQO are in concordance with a Low Carbon Society. Was concluded that some LQO proposed in the landscape catalogues didn't relate to the vision of a Low Carbon Society. Was proposed some modifications on the existing LQO and suggest that the Landscape Observatory apply this study to all landscape catalogues in order to reduce Catalonia carbon emissions and increase its capture. One fragility of this study was the impossibility (due to time and information limitations) to consider all the variables in a landscape that emit and capture CO_2. It's also recommended that the Landscape Observatory needs more detailed data such as: land uses, type of crops (rainfield or irrigation), type of soil, type of industry, etc. The detailed of this information will contribute to a more concrete proposal on reducing the emissions in the source, without changing landscape character. It's also recommended that this evaluation of the emission/capture of the CO_2 should be made to Catalan landscapes in parallel, so we could have a more realistic idea of what changes should be made to keep their character.

The changes in the landscape should respect all the features and characteristic of the landscape as well as improve them. The increase of the forest area and the management of them should be encouraged, as well as the management of the riparian gallery, the use of "environment friendly" energy and machinery and the cultivation of crops that don't use so many resources.

To finish, it's crucial to highlight that this study only could achieve this detail, due to all the work made in the Landscape Observatory of Catalonia, especially regarding the importance of mapping and characterise the Catalan landscape, understanding its past and projecting its future, never forgetting their identity.

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Annex

Annex 1 - Organization of a Landscape Catalogue

Volume I: Territorial area (Nogué, Joan; Sala, Pere; Grau, Jordi, 2016).

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Methodology

Natural factors that condition the landscape

Historical evolution of the landscape

The current landscape and its dynamics (currents and future)

Artistic expression of the landscape

Values in the landscape

Routes and points for observing and enjoying the landscape

Landscape evaluation

Special attention landscape

Landscape quality objectives

Criteria and actions

Conclusions

Reference documentation

Annex 2 - Contents of a Landscape Unit

Volume II: Landscape units (Nogué, Joan; Sala, Pere; Grau, Jordi, 2016).

Content of each landscape unit

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Representative photograph of the landscape

Distinctive features

Main values

Composition of four photographs of values and distinctive features

Location map

Natural elements that make up the landscape

Historic evolution

The current landscape and its dynamics

Artistic expression of the landscape

Values in the landscape

Main routes and points for observing the landscape

Landscape evaluation

Landscape quality objectives

Criteria and action

Maps of observation points, itineraries and landscape values

Annex 3 - Landscape units per Landscape Catalogue

Alt Pirineu i Aran

Name	Distinctive features
Altes Nogueres	High shale mountains with important lagoons. Village with surrounding fields. Habitats from protected species.
Boumort – Collegats	Great canyon of Noguera Pallaresa. Forest landscapes and rocky landscapes and cliffs.
Cadí	Limestone cliffs that plunge into the narrow valleys. The left side of Segre valley, wooded and shadow, diverge from the shining Josa valley.
Cims i Estanys d'Aigüestortes i Sant Maurici	Landscape of glacier lakes, and great scenic background. Many lakes and waterfowls. Low human factor, but with impacts case by hydroelectric infrastructures.
Conca de Tremp	Noguera Pallaresa has been for centuries the path for people and materials to the Pyrenees. Mineral landscape with a great geological and paleontological interest.
Congost del Segre	Landscape closed by cliffs and calcareous walls, only opens in the reservoir of Oliana and in the valleys above, of Coll de Nargó and Organyà. Historical territory with the largest gorge of the Catalan Pyrenees
Era Baisha Val d'Aran	Great altitude gradient between peaks and valley bottoms structured by Garona. Agroforestry landscapes with Atlantic climate.
Era Nauta Val d'Aran	Glacial valleys. Model of urbanization associated to the ski equipment and the centrality of Viella, economic polarity and services. Extensive pastures, sunny slopes in chromatic contrast with dark woods.
La Terreta	Isolated region of the Mediterranean mountains. Dispersed villages, deep ravines of border character.
La Vansa	Isolated soup, with broken orography. Giant limestone between Port del Comte and Cadí. Cliffs that plunge into the Segre valley.
Massís de l'Orri – Valls de Castellbò i d'Aguilar	High and medium mountains, with massive reliefs and shapes, and deep and isolated valleys. Populations of medieval times among ancient pastures, with meadows and terraced fields surrounded by stone walls.

Pastures de l'Alt Pirineu	Landscape nestled by Noguera Pallaresa and Noguera Ribagorça-na. Mountains maselles, covered with green pastures in summer and snow in winter. Highlights include the Romanesque Vall de Boí and the transformations of Vall Fosca.
Plana de l'Urgellet	Great valley of dry mountain landscape, with urban landscape of Seu d'Urgell in the middle. Survival of the agricultural sector that maintains a balance between cities, towns and forest on the slopes of the moun-tains.
Rodalia d'Oli-ana	Continental Mediterranean landscape crossed by the Segre valley. Or-chards and crops on both sides of the river combined with riparian veg-etation and calcareous cliffs that determine the end of the Segre gorge.
Sant Gervàs - Montcortès	Populations immersed in valleys hidden in the softer foothills of the Pyrenees. Cultivated plateaus and hydroelectric landscapes.
Solana del Baridà	Landscapes of the Pyrenees Alts mixed with Pre-Pyrenean limestones and the landscape cerda. The plateaus preserve ancient and exten-sive cultivation landscapes. Villages of traditional architecture in stone and slate located in a position of watchman on Cadí and of the plain of Urgellet.
Vall Cerdana	Reticular structure of the agricultural landscapes of the plain crossed by the Segre river. Settlements spread around the plain, with Puigc-erdà strategic position.
Vall d'Àneu	High valleys of glacial origin with a landscape of mixture of cultures, people and riverside margins. Village network at the bottom of the val-ley, on the slopes or in the side valleys.

Camp de Tarragona

Name	Distinctive features
Alt Gaià	Mountainous character, with altitudes around 1,000 m. Predomi-nantly limestone, covered with white pine and shrub. The river Gaià crosses the unit from north to south.
Baix Gaià	Pines and large urbanizations in the western sector and agriculture in the north and east sector. Natural areas in the coastal strip, sub-ject to urban growth.

Baix Priorat	Flat relief, gently undulating. Granite and slate in the Falset-Marçà fosse, and limestone and sedimentary materials in the plains and mountains. Agricultural landscape consisting of vineyards, olive trees, almond and hazelnut trees. Spontaneous vegetation.
Baixa Segarra	Relief shaped by the high course of the rivers Corb and Gaià with an average altitude of about 700 m. Predominance of herbaceous crops of rainfed. Some white pine pinewoods. Very relevant role of livestock.
Camps de Santes Creus	Small fluvial plains and terraces along the river Gaià structured with riverside vegetation. Cultivation of vineyards and pinewoods of white pine and Mediterranean vegetation. The monastery of Santes Creus is an important element.
Camps del Francolí	Diverse and heterogeneous agricultural plain dominated by irrigated woody crops. Contrast between the industrial activities of petrochemical complexes.
Conca d'Alforja - Vilaplana	Open depressions with forest masses on the slopes of the surrounding mountains. Cultivation of olive trees and hazelnuts. Villages of rural and residential character by the proximity of Reus.
Conca de Poblet	Erosion basin of the Francolí and Anguera rivers. The predominant materials are marl, sandstone and shale. Predominantly agricultural landscape, especially winery.
El Montmell	Mountains and hills with steep and rough and dry landscape. Viewpoint on the Baix Penedès plain. Pinewoods, patches of oak and oak leaved, vine cultivation. Remains of abandoned heritage. Large estates scattered.
Escornalbou - Puigcerver	Narrow valleys separated by mountains and hills of gentle slopes. Agricultural villages on the edges of the Riudecanyes and Riudecols streams. Rainfed crops. Aleppo pine and scrub rockrose and heather.
Garraf	Mediterranean low mountains near the sea where coexists a combination of developments and pine forest. The vegetation looks quite degraded.
La Mussara	Rough mountainous forest of more than 1.000 m and some plains of dry land. Pinewood of white, red and Austrian pine, oak.

Litoral del camp	Low coastline densely urbanized in the first line and with agricultural area inside with woody crops.
Litoral del Penedès	Low coastline densely urbanized. Pinewood of white pine, scrub and maquis fragments of palm in the small hills away from the coast. Area cultivated small and fragmented.
Massís de Bonastre	Low mountains between the agricultural plains of vineyards, olive, almond and hazelnut. Abandonment farm in the hills and mountains colonized by vegetation.
Montsant	Serra with big cliffs, caves and monoliths. Highlighting the deep ravines Fraguerau gorge. Agricultural area in the vicinity of the villages. Traces of intense agricultural activity in the past.
Muntanyes de Prades	Mountainous massifs up to 1,200 meters high. Predominance of silicon materials: Paleozoic granites and slates. Mediterranean vegetation covers with a great variety of forests.
Plana de l'Alt Camp	Agricultural plain enclosed by an amphitheater of mountains. Cereal crops and vineyards. Industrial parks in Valls and Pla de Santa Maria.
Plana de l'Hospitalet de l'Infant	Coastal plain with pine forests and fields of rainfed meadows. Housing complexes on the coastal strip. Low coast with long sandy beaches. Small delta at the mouth of the river Llastres.
Plana del Baix Camp	Agricultural plain with a network of parallel streams. Woody crops that alternate with irrigated fruit and vegetable crops. Rural locations with residential, industrial and commercial growth.
Plana del Baix Penedès	Agricultural plain with small hills and hills of gentle slopes. Predominance of vineyards with arable crops in the south. The main water course is the La Bisbal river. Many roads.
Priorat històric	Relief broken, low mountains and hills with slopes heavily inclined. Predominance of vineyards with wineries buildings. Mediterranean vegetation sparse. Rural and compact nuclei.
Reus - Tarragona	Large urbanized area with a dense network of communication infrastructure. Petrochemical industries. Suburban landscape between Reus and Tarragona.
Serra de Llaberia	Mediterranean mountains with almost 1,000 m of altitude. Calcareous masses surrounded by cliffs. Vegetation with white pine, rosemary thickets and weeds. Shortly populated agricultural areas with small valleys and plateaus interiors.

Valle del Silenci	Valleys Ulldemolins and Cornudella de Montsant excavated materials Eocene tender. Mediterranean scrub vegetation and oak trees, and sunny plateaus and pine and oak in the shade. Crops at the bottom of valleys.

Comarques Centrals

Name	Distinctive features
Cabrerès - Puigsacalm	Plateau bordered by cliffs. Dense and lush mosaic of herbaceous crops pastures and forests. Fund scenic landmarks.
Capçaleres del Llobregat	Mountain landscape with alpine strong folds that give a certain look rugged and steep. The towns are small, but well distributed throughout the territory.
Conca d'Òdena	Area excavated by the erosion of the river and its tributaries Anoia, surrounded by several hills and mountains of moderate height. Some highlights are the irrigated crops, the urban Igualada, many old factories and industrial services and newer.
Conca salina	Mountainous Landscape force, serrated valleys and low-flying; at some points stand out mine tailings, witness the mining of sodium salt and potassium.
Lluçanès	Open landscapes, gently undulating and partially covered by lush riverine vegetation along several lines of water that cross them. It forms a mosaic of fields and forests that is home villages not very large and distributed.
El Moianès	High plateau with small villages and isolated farmhouses, dominated by cereal farming with wet woods of holm oaks and pine in the periphery.
Montserrat	Emblematic mountain cluster and a well established characteristic relief with numerous cliffs and needles round. The vegetation of the mountain oak scrub and shady channels in the lower and above.
Rubió – Castelltallat – Pinós	Succession of different mountain ranges average orientations parallel from east to west, which include mosaic forests and fields and the presence of some villages, isolated farmsteads and guard towers.

Pla de Bages	Flat relief, some hills and even the passage of Cardener and Llobregat, an important source of industry. Traditionally, agriculture, rainfed and irrigated has been the main occupation of the area, but has been giving way to the growth of residential areas, infrastructure and industrial estates around Manresa and neighboring towns.
Plana de Vic	Intensely cultivated and densely populated flat areas, where they coexist with industrial areas, fields, and farms. The river Ter crosses much of the plain and facilitated industrial development of coastal villages.
Replans del Berguedà	The river crosses the Llobregat drive from north to south and welcomes its edge populations with a recent industrial past. The parties further away from the river, forested hills, streams and cultivated plateaus are sparsely populated and are home to villages and farmhouses focus its economy on farming activities.
Replans del Solsonès	Mountainous slopes of the Pyrenees, covered with forests, formed by a succession of hills and areas with an agricultural and forestry vocation, crossed by the river Cardener. With the exception of the city of Solsona and the scattered settlement there is little organization, organized mainly in large farms.
Ribera Salada	Mountainous area with the valleys of the river Salada and its tributaries. It dominates the forest and the fields of cultivation. Not many towns: the settlement is well dispersed in the form of large farms.
Serres d'Ancosa	Encinglerades mountains, flat peaks and troughs. They emphasize the alignments of limestone heavily bent and populated by pines, clay depressions dedicated to cereal, where are located most of the farms and villages.
Valls de Lord	Area acinglerat steep and dominated a landscape of high mountains in the north, with quite dense vegetation and some meadows. In the south, some plateaus and mountains form a mountainous landscape.
Valls de l'Anoia	Agroforestry landscape, very undulating and marked by the passage of Anoia and Riudebitlles. Cultivation of vines, cereals and some fruits. Industries and mills on river terraces and large wineries cellar complete this field landscape.

Comarques Gironines

Name	Distinctive features
Alta Garrotxa	Muntanyam formed by limestone cliffs, steep and rugged mountain ranges. Gorges, valleys and waterfalls of Llierca and Muga. Variety of forest environments. Chapels, small churches and small villages scattered.
Ardenya - Cadiretes	High coast with high cliffs articulated with small inlets, very urbanized. Very compact and dense vegetation, forests of cork oaks and pines. Resorts on the coast and developments in the forest landscape.
Els Aspres	Low mountains, gently undulating. Forest characteristic cork, wine regions. Small medieval villages.
Alt Ter	Mains and parallel valleys and articulated by the river Ter and Freser, with industrial colonies. Deciduous forests and mountain pine forests.
Cap de Creus	Rocky coast with high cliffs, coves and small bays articulated. Mediterranean reliefs of little height. Large areas of scrub, vineyards and olive groves.
Costa Brava	Mountains alternated by valleys and plains. A steep and rocky coast with cliffs, which opens into coves and bays. Dense forests cover of pines, oaks and cork oaks. Great tourism development.
Empordanet – Baix Ter	Mediterranean landscape of low limestone mountains with scrub and groves. The lower alluvial plain of the River Ter. Coastal alluvial lowland plain with dunes, ponds and marshes. Rich and diverse agricultural landscape.
Estany de Banyoles	Landscape Lake Pond, urban agroforestry articulated by historical houses, neighborhoods and small rural and agro-livestock farms.
Garrotxa d'Empordà	Scrubland transition with alternating hills and valleys. Forest cover predominantly westward. Agricultural land on the plains of the river Manol. Medieval urban plot.
Las Gavarres	Mediterranean scrubland dominated by cork oak forest, oak and pine with maquis and scrub. Agricultural areas in the alluvial terraces of the Ter. Locations located in peripheral areas.
Les Guilleries	Low and medium range of granite materials. Predominance of forest cover. Planting of forest species for industrial purposes. Large reservoirs of Sau, Susqueda and Pasteral.

Pla de Girona	Agroforestry mosaic of arable crops and mixed forest patches. Landscape conditioned by the urban area of Girona, with large infrastructures of transport and communications, several suburban landscapes.
Plana de l'Empordà	Agricultural plain open to the sea and surrounded by an amphitheater of mountains. Alluvial sediments of the Muga and Fluvià rivers. Pantanal wetland zone with international importance. Urban development on the Figueres-Roses axis.
Plano de la Selva	Gently rolling plain between the mountains, with an agroforestry landscape and forest spots. Traces of volcanic activity. Endorheic areas with wetlands and flood plains. Industrial and service areas linked to the airport and the infrastructure corridor.
Rocacorba	Mountains covered with dense forest and dramatic cliffs. Llémena Valley and plans Canet d'Adri rural landscape almost untouched. Featured volcanic hills.
Salines – l'Albera	Scenic mountains of the Alt Emporda. Hydrographic network composed of many rivers, streams and rivers. And deciduous oaks, and pastoral meadows.
Terraprims	Undulating terrain crisscrossed by rivers and streams. Mosaics agroforestry crop fields, white pine and oak. Ter river plain of irrigated crops. Scattered population.
Vall de Camprodon	High mountain with glacier modeling and forests of pine and alpine meadows. The rivers Ter and Ritort articulated with the roads.
Valls d'Olot	Articulated mountainous rivers Fluvià and Ser. Morphologies produced by Quaternary volcanism. Mosaic crops, pastures, forests, farms and small towns.
Valls del Freser	Pyrenees Mountains articulated by the river Freser. Alpine meadows mosaic of deciduous forests and meadows of the valley bottom. Small towns.

Regió Metropolitana de Barcelona

Name	Distinctive features
Alt Maresme	Landscape of coastline with some granite cliffs and a narrow coastal plain, occupied by tourist resorts and infrastructure. Agricultural activity currently residual characterized by strawberries in greenhouses hillside, amid a vigorous forest land.

Baix Maresme	Coastal plain and sunny relief kindest of coastal mountains. A continuous center follows the coast and valleys of streams connecting the cores of the sea and mountains. In the lower parts remains agriculture greenhouse, while the slopes and the upper parts are pine, scrub and vines.
Baix Montseny	Strip moderate slope, mostly wooded, except the main valley bottoms, where the arable crops and poplar alternate with residential and industrial uses.
Baixa Tordera	Alluvial advantage for both agricultural irrigation and for the planting of poplar, as well as various industries. The unit is crossed by numerous infrastructure.
Cingles de Bertí i Gallifa	Limestone cliffs, interspersed with red clay. Areas with bare rock to very forested areas, mostly pines. At the foot of cliffs there are numerous developments.
Collserola	Metropolitan mountain isolated and surrounded by urban and industrial fabric. Vegetation bush and pine forest in the sun and oak trees in the shade.
Delta del Llobregat	Plains with value in agricultural irrigated areas, despite the pressure of infrastructures, industrial parks and urban areas. On the coast there are gaps and important wetlands, once abundant.
Garraf	Limestone cliffs with ravines or recessed valleys and some clay plains. Coastal maquis vegetation, shrubs and palmetto, along with forests of pine. Several residential areas and towns bordering the field.
Montseny	Massif dominant in the coastal mountain range. Steep and verdant relief, with vegetation of moist Mediterranean mountain areas and central Europe.
Muntanyes d'Ordal	Mountainous landscape populated by pines and oaks crossed by streams and tributaries of the Llobregat, with cliffs and plateaus. Several housing developments dot the landscape.
Pla de Barcelona	Urban landscape continues which includes flat lands of alluvium of Llobregat and Besòs with hills and irregular lands next to the foothills of the coastal mountains.
Pla de Montserrat	Plain between the mountains and coastal littoral, furrowed by the stream of Llobregat and Magarola. The landscape is dominated by large industrial, urban and residential areas.

Plana del Garraf	Extensive coastal plain surrounded by limestone reliefs. At the front there are coastal towns, cliffs and beaches and inland, vineyards and dry fruit that gives way to the intense urbanization.
Plana del Penedès	Landscape open agricultural plain, gently undulating, dominated by farming small plots of vines, interspersed with gentle hills and streams. Great communication infrastructures believe the most straightforward.
Plana del Vallès	Undulating plain small ridges and valleys that are built into strips, following the river valleys and the main lines of communication. Large industrial and logistic parts flatter and forest remnants in the highest part.
Sant Llorenç del Munt, l'Obac i el Cairat	Rugged rocky landscape of reddish conglomerate, which is a characteristic rounded peaks. Dominates the forest.
Serra de Marina	Continuous coastal mountain range that separates the inland plain of the coast. Relay rounded rock mainly granite, pine vegetation.
Vall baixa del Llobregat	Floodplains and low terraces of the river Llobregat. The valley has been occupied by an infrastructure corridor, several industrial areas and urban centers. The presence of garden crops and fruit trees, abundant before has been reduced on both sides of the river.
Xaragalls del Vallès	Deep ravines alternating with ridges shaped ass back supporting numerous roads and residential areas. Agricultural activity is confined to the hollows and natural vegetation altered much, consists mainly of pine and scrub.

Terres de l'Ebre

Name	Distinctive features
Altiplà de La Terra Alta	Plateau with gentle undulations. Dominate space agro forestry especially vineyards with almond and olive sectors.
Barrufemes	Narrow River Ebro with some crops irrigated and dryland vineyard and olive plateau. Forests of white pine and rosemary scrubs. Limestone formations on the river Canaletes.
Burgans ou Plana del Burgar	Rift with a mosaic of crops and agroforestry. Structured agricultural parcels and small dry-stone walls, scattered farms and houses.

Costers de l'Ebre	Almost arid Mediterranean climate. Forest land with some rainforest crops in the bottom of the valleys and irrigated on the river terraces. Double settlements in the river plains and high land.
Cubeta de Móra	Area of agricultural crops with predominance of irrigated sweet fruit. Populations scattered near the river Ebro, heritage of old hydraulic wheels and compact urban areas.
Delta de l'Ebre	Relief plan confluence of natural and human. Much of protected natural areas. Character agricultural cultivation of rice and scattered buildings.
Litoral del baix Ebre	Long narrow coastal strip alternating small cliffs, rocky beaches and tourist resorts. Interior wooded hills, olive trees, ravines. Parts transformed by developments and infrastructure.
Los Ports	Massive limestone materials with very abrupt relief. Scenic background visible Terres de l'Ebre. Very steep eastern slope with many cliffs. West slope with abundant vegetation, rivers and deep gorges.
Muntanyes de Tivissa- Vandellòs	Mediterranean hilly and rugged altitudes around 700 m. Vegetation with weeds, scrub oak and thermophilic. The river Llastres structure of the northern sector, and a network of canyons to the south. Small towns.
Paisagem fluvial do Ebre	Ebro River fluvial terraces, irrigation canals and wetlands. Agricultural landscape and landscape transformed into urban land and infrastructure. Cultural heritage linked to water.
Plana del Baix Ebre – Montsià	Plain with gentle slopes. Rural landscape of rainforest with predominance of the olive tree. Important built heritage, defence towers and dry stone rural constructions.
Riberes de l'Algars	Ravines and valleys that descend from the mountains to the river Algars. To the south the Plans d'Horta with the agriculture of dry land. Agroforestry landscape with traditional cultivation of grains, vines and olive trees.
Serra del Tormo	Low Mediterranean, steep cliffs and views of the Sierra de la Higuera. Vegetation rosemary scrubs and white pine. Scarce network of ravines and streams, river Ebre crosses the Pas de l'Ase.

Serres de Cardó – El Boix	Relief quite steep and moderate altitudes with numerous cliffs and deep ravines. High visual exposure from many towns and road infrastructure. Limited agricultural land in small valleys.
Serres de Montsià- Godall	Two mountain ranges parallel to the coast, with a tectonic fossa that separates them, with important routes. Narrow coastline with tourism and construction sectors. Agricultural interior of olive trees and cereals.
Serres de Pàndols – Cavalls	Steep relief and moderate altitudes with unique morphologies. Predominance of forest landscape and bush.
Vassantes de Tivenys – Coll de l'Alba	Soft slopes structured by small ravines that are directed to the river Ebro. Rural landscape of olive groves pines and bush. Semi-urban landscape in the neighbourhood of Tortosa.

Terres de Lleida

Name	Distinctive features
Alt Sió	Flatlands of slightly undulating with more altitude and vegetation clearing and cultivation of irrigated land to the west. Medieval mills. Rural and scattered population, with Agramunt and Guissona origin castral.
Aspres del Montsec ou de La Noguera	Saw blades that combine rocks and water reservoirs of the Segre and Noguera Pallaresa and Noguera Ribagorçana. Segre forms a valley hemmed in on the banks lend to the irrigation and human settlement.
Baix Segrià	Soft and wavy relief, with hills and a patchwork of agricultural parcels currently irrigated arid past. Rural settlements concentrated in the eastern border, near the Segre.
Baix Siò	Isolated valley in the final stretch of the river of Sió from Agramenunt to Segre. Arable crops irrigated and dryland plots typical terraced garden and the slight slope of the rolling hills. Rural settlements aligned along the river.
Costers de Segarra	Western side of the plateau of the Segarra. Rainfed arable crops. Settlement of fragments scattered in many villages. Many castles in the hills. It is crossed by a corridor infrastructure and communications.

Garrigues Altes	Relay graonats platform structure. Elongated ridges with narrow valleys. Crops dry fruit, scrubland scrubs and white pine. Dry stone constructions in areas with terraced slope.
Garrigues baixes e Vall del Corb	Reliefs broken in a succession of valleys and hills lengthened. Slopes agricultural terraces and stone walls, vaulted cabins and houses. Abundance of quarries. Rural population and scarce.
Horta de Pinyana	Soft relay connecting platform Almenar-Alguaire the Segre and Noguera Ribagorçana. Predominance of sweet fruit crops extensive herbaceous crops. The Lleida urban system alters the unit with more dispersed rural settlements to the north.
Mig Segre	Tram through the river Segre with a plateau with open valleys and plains. Traditional rainfed agriculture alternating with some irrigated plots. Villas merchants' intermediaries between the plain and the mountain.
Montsec	Rocky mountain range in two steps and a landing. Gorges Noguera Ribagorçana and Noguera Pallaresa. Ager crops in the valley and basin Meià. Rural population and scarce.
Paisagem fluvial do Segre	Low terraces from the banks of the Segre and Noguera Ribagorçana to the confluence with the river Ebro. Small plots of hundred-year-old gardens. Population concentrated in the cities and spread out in the countryside.
Plana d'Algerri - Balaguer	Flat land between the rivers Segre and Noguera Ribagorçana. Agricultural lands with the recent transformation into irrigated agriculture with extensive arable crops.
Plana d'Almenar e Alguaire	Broad horizontal platform with more or less accentuated slopes. Dominated by wheat fields and there is no outstanding infrastructure.
Plana d'Urgell	Territory plain relief and mild horizons straight. Large-scale irrigation and land have changed cereal in gardens and orchards. Populations most outstanding major roads and the rest are linked to agricultural and livestock activities.
Regadius del canal d'Aragó e Catalunya	Plain to the west of Lleida irrigated by several channels. Prevalence of large agricultural parcels. Raimat wine as a tourist attraction.

Secants d'Utx-esa	Landscape transition between the river and the interior continental elevated platform Garrigues. Terrace medium outside the Segre River wetlands and farmland irrigation recent landscape of dry cereal in the northern semi-arid Mediterranean climate, dry fruit and valleys in the southern sector.
Secans de Belianes e d'Ondara	Soft reliefs formed by wide flat bottom valleys and hills and plateaus of modest height. Parallel, elongated and narrow agricultural fields. Extraction activities of gravel and pebbles of the Corb river.
Serrats de Sanaüja e Llanera	Low mountains with heights between 500 and 1000 m, undulating mountains of forest dominance. Scattered population, a large number of castles and observation towers.
Serres de Bellmunt e Almenara	Agricultural plots parallel to the outcrop of plaster. Small woods alternate with cereal fields. Population scarce, without rivers and scarce roads. Prevalence of agricultural farms.
Vall de Rialb	Forest landscape with some open areas where tiles have worked in the forests. Deeply deserted. Only transformed by the recent forest Rialb reservoir.
Vall del Llobregòs	Valley of the river Llobregós and smooth reliefs between Siò and Segre with a longitudinal structure of materials. Dense occupation by rainfed crops. Scattered rural population.

Annex 4 - Low carbon landscape factors

Energy balance – demand/ supply

Description: The energy challenge in the twenty-first century is to bring about a new transition, towards a more sustainable energy system characterized by universal access to energy services, and security and reliability of supply from efficient, low-carbon sources.

Questions / Land use	Does the LU relate to the energy balance?	If yes why?	Is this "why" very positive or very negative?	Value
Bush	yes	Biomass	Positive	+1
Intensive Crop	yes	Machinery, watering, conservation, transportation	Negative	-2
Extensive Crop	yes	Machinery, watering, conservation, transportation	Negative	-1
Grassland	yes	Machinery, watering, conservation, transportation	Negative	-2
Water	yes	Hydroelectric power,	Positive	+3
Isolated residences	yes	Human consumption, transportation, street illumination	Negative	-3
Forest	yes	Biomass,	Positive	+2
Quarry	yes	Machinery, watering, conservation, transportation	Negative	-2
Riparian forest	yes	Biomass	Positive	+2
River	yes	Hydroelectric power	Positive	+2
Road	yes	Transports, illumination, management	Negative	-2
Urban settlement	yes	Human consumption, transportation, street illumination	Negative	-2
Woody plants	yes	Biomass	Positive	+1
Animals farms	yes	Infrastructures, conservation of the food	Negative	-2
Biogas plant	yes	Production of energy	Positive	+3
Power lines	yes	Transmit the energy to the different places where is use	Positive	+3
Golf	yes	Management, illumination, infrastructures	Negative	-2

Water use balance – demand/ supply

Description: The water use balance has into account the ability to retain/use water or provide water to the consume of the different land uses (LU).

Questions / Land use	Does the LU relate to the water use balance?	If yes why?	Is this "why" very positive or very negative?	Value
Bush	yes	Water retention in the soil	Negative	-1
Intensive Crop	yes	Demand big quantities of water,	Negative	-3
Extensive Crop	yes	Demand big quantities of water	Negative	-2
Grassland	yes	Demand big quantities of water	Negative	-3
Water lines	yes	Preserves open waters lines	Positive	+3
Isolated residences	yes	Demand big quantities of water	Negative	-3
Forest	yes	Water retention in the soil	Negative	-1
Quarry	yes	Demand of water	Negative	-2
Riparian forest	yes	Use the water in the soil	Positive	+1
River	yes	Font of drinkable water	Positive	+3
Road	no	-	-	-
Urban settlement	yes	Demand big quantities of water	Negative	-3
Woody plants	yes	Water retention in the soil	Negative	-1
Animals farms	yes	Demand big quantities of water	Negative	-3
Biogas plant	yes	Demand of water	Negative	-2
Power lines	no	-	-	-
Golf	yes	Demand big quantities of water, use of drinking water, no reuse of water	Negative	-3

Water quality balance – pollution/ purification

Description: The water quality balance tries to evaluate the capacity of each land use of purification or polluted the water for human consume.

Questions / Land use	Does the LU relate to the water quality balance?	If yes why?	Is this "why" very positive or very negative?	Value
Bush	yes	Cleans the water, create a healthier environment	Positive	+2
Intensive Crop	yes	Pollute with fertilizers and pesticides, contaminate the drinking water	Negative	-3
Extensive Crop	yes	Pollute the water	Negative	-1
Grassland	yes	Pollute with fertilizers and pesticides, contaminate the drinking water	Negative	-3
Water	no	-	-	-
Isolated residences	yes	Pollute the water	Negative	-1
Forest	yes	Cleans the water, create a healthier environment	Positive	+3
Quarry	yes	Pollute the water	Negative	
Riparian forest	yes	Cleans the water, create a healthier environment, contributes to the growth of biodiversity	Positive	+3
River	no	-	-	-
Road	yes	Pollute the water, contaminates the soil	Negative	-2
Urban settlement	yes	Pollute the water	Negative	-2
Woody plants	yes	Cleans the water, create a healthier environment	Positive	+2
Animals farms	yes	Pollute the water	Negative	-2
Biogas plant	yes	Pollute the water	Negative	-1
Power lines	no	-	-	-
Golf	yes	Pesticides. Pollute the water	Negative	-2

Erosion balance –control/ forcing

Description : The erosion balance evaluate the capacity to fixate or accelerate the soil erosion by each land use.

Questions / Land use	Does the LU relate to the erosion balance?	If yes why?	Is this "why" very positive or very negative?	Value
Bush	yes	Fixation of the soil	Positive	+2
Intensive Crop	yes	Cyclic movement of the soil	Negative	-2
Extensive Crop	yes	Cyclic movement of the soil	Negative	-2
Grassland	yes	Cyclic movement of the soil	Negative	-1
Water	yes	Fixation of the soil	Positive	+1
Isolated residences	yes	Soil compaction	Negative	-1
Forest	yes	Fixation of the soil	Positive	+3
Quarry	yes	Removal of the soil	Negative	-3
Riparian forest	yes	Fixation of the soil	Positive	+2
River	yes	Displacement of particles	Negative	-1
Road	yes	Soil compaction	Negative	-2
Urban settlement	yes	Soil compaction	Negative	-2
Woody plants	yes	Fixation of the soil	Positive	+3
Animals farms	yes	Soil compaction	Negative	-1
Biogas plant	yes	Soil compaction	Negative	-1
Power lines	no	-	-	-
Golf	yes	Fixation of the soil	Positive	+1

Carbon balance – emissions/ capture

Description: The emissions or capture of CO_2 or CO_2 eq. helps to evaluate the capacity of a landscape to become a low carbon one as well as identifies the land uses that emit the bigger quantities of CO_2. In a low carbon society the carbon balance ideally should be with higher quantity of capture than emissions or zero, but to achieve a low carbon landscape the emissions have to be as little as possible without compromise the economy of the landscape.

Questions / Land use	Does the LU relate to the carbon balance?	If yes why?	Is this "why" positive or negative?	Value
Bush	yes	Fixate the carbon in the woody parts and helps the fixation by the soil	Positive	+2
Intensive Crop	yes	Wears the soil and uses machinery and pesticides and industrialize fertilizers	Negative	-3
Extensive Crop	yes	Use of organic fertilizers, wears the soil, transportation of the food	Negative	-1
Grassland	yes	Machinery, storage of crops	Negative	-2
Water	yes	Storage of the CO_2 in ocean waters, capture of carbon by the superficial water	Positive	+2
Isolated residences	yes	Burn of the gas and oil	Negative	-2
Forest	yes	Fixate the carbon in the woody parts and helps the fixation by the soil	Positive	+3
Quarry	yes	Wears the soil, destroy natural carbon storage	Negative	-3
Riparian forest	yes	Fixate the carbon in the woody parts and helps the fixation by the soil	Positive	+3
River	yes	Capture of the carbon by the superficial water	Positive	+1
Road	yes	Transportation, materials	Negative	-2
Urban settlement	yes	Burn of the gas and oil, transportation	Negative	-2
Woody plants	yes	Fixate the carbon in the woody parts and helps the fixation by the soil	Positive	+2
Animals farms	yes	Big infrastructures, machineries,	Negative	-2
Biogas plant	yes	Recollection of the waste	Positive	+2
Power lines	yes	Majority of the power comes from the non renewable sources	Negative	-2
Golf	yes	Management, machinery, open spaces with reduce vegetation	Negative	-2